VOL. 107 • NO. 2784 • PAGES 433-446

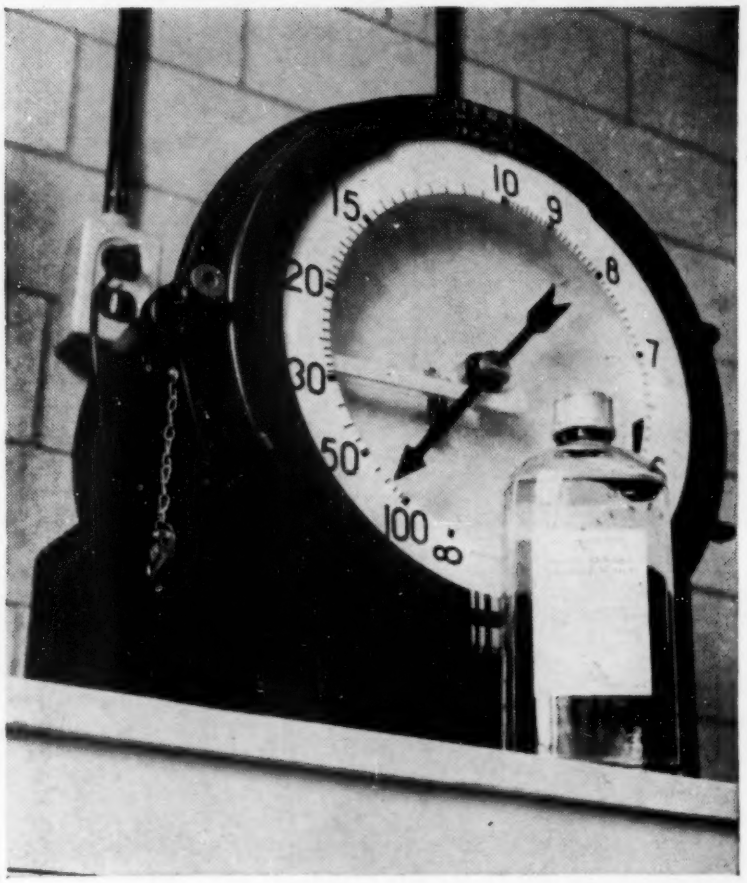
May 7, 1948

Science

PERIODICAL ROOM
GENERAL LIBRARY
UNIV. OF MICH.

Sloan-Kettering Institute for Cancer Research

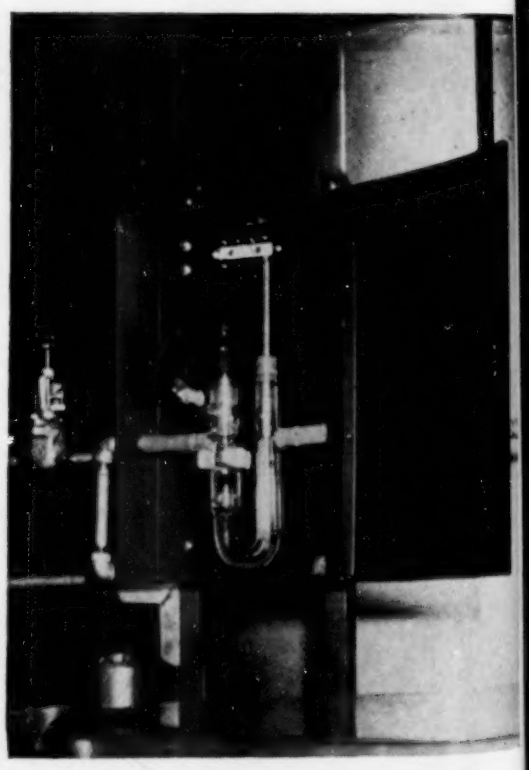
(See page 467)



Upjohn Co., Kalamazoo, Mich., use this Micromax Recorder to show the constant purity of the sterile, double-distilled, pyrogen-free water which is one of their products. Shown below is the equipment's metal-boxed conductivity-cell assembly.

GUARDIAN for a Water Still

An overall check of the purity of water from any automatic still is provided by a Micromax Recorder of the type shown here.



This instrument can warn the chemist or biologist against such difficulties as using water before entrained air has been swept out of the still. It also warns if improper or careless operation causes foaming or priming, and thus carries undistilled water to the effluent. Regardless of cause, if the effluent isn't of the desired conductivity, the Micromax indicates the fact, and can of course operate an alarm light or bell if required.

One of the equipment's greatest advantages, in a large laboratory, is that the automatically-drawn record chart gives written proof of water purity.

Catalog EN-95 describes the equipment and will be sent on request, but if you have a definite application in mind, an L&N engineer will be glad to supply individualized information. Leeds & Northrup Co., 4926 Stenton Ave., Philadelphia 44, Pa.

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

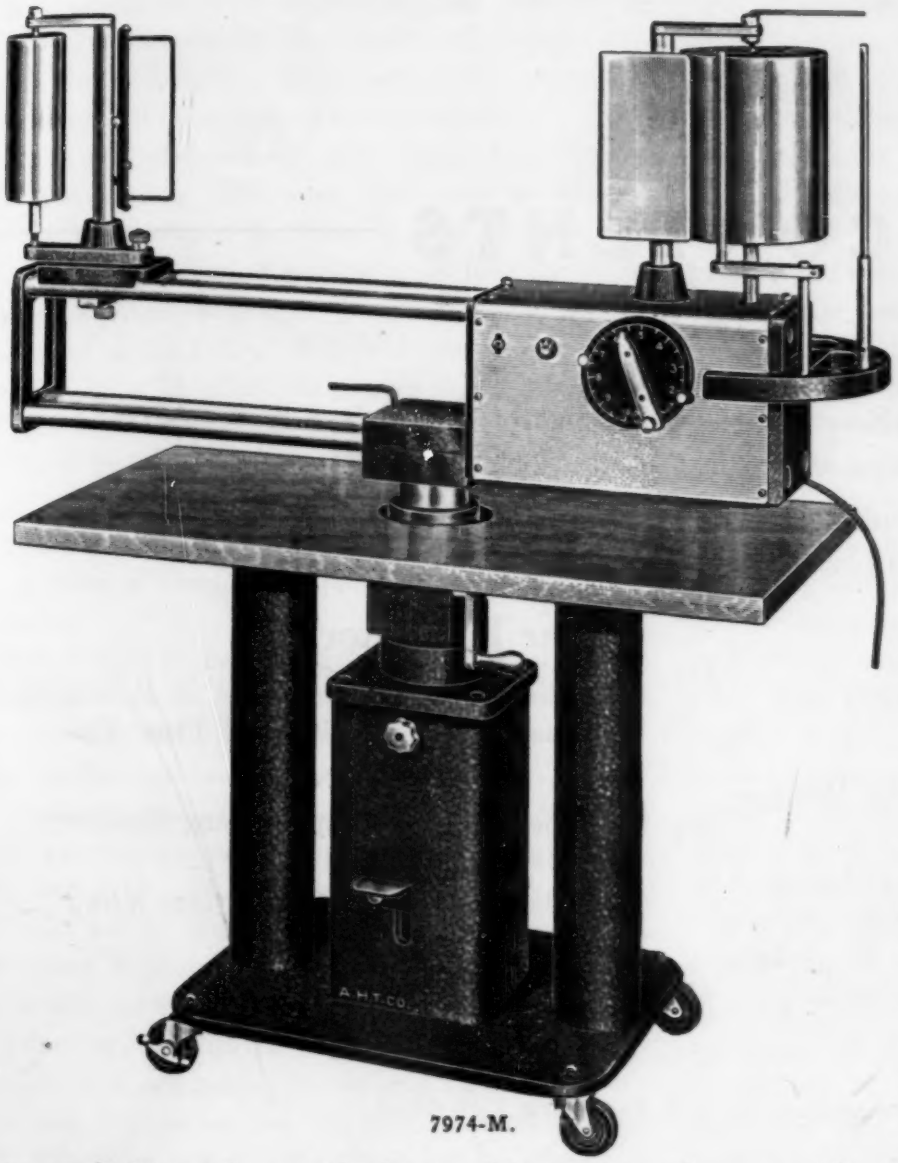
LEEDS & NORTHRUP CO.

Jrl Ad N-95(3)

BOEHNKE

UNIVERSAL KYMOGRAPH

A new model, of great rigidity, in which instantaneous change of speed can be made simply by turning the lever on the dial



7974-M.

KYMOGRAPH, BOEHNKE UNIVERSAL. A new model, of great rigidity, driven by a 1/15 h.p. constant speed induction motor and a precision friction type transmission. Speed can be varied from 0 to 351 cm per minute and can be changed instantaneously simply by turning the lever on the dial which indicates a direct percentage of maximum speed. Principal parts are of aluminum, with 10-inch drums of brass, and shafts of Stainless steel.

Available in both the Single Drum Long Paper Model, as illustrated, and Dual Drum Long Paper Model for making two separate records, either of which can be furnished with an Extension which permits maximum paper length of 172 inches. A Continuous Paper Attachment and other accessories are available and provide for a wide variety of uses. All models are offered either with or without the new type hydraulically operated table illustrated above which provides for elevation of the Kymograph up to 14 inches above table top.

7974-M. Kymograph Assembly, complete with table, for use on 115 volts, 60 cycles a.c. **$1,132.25**

7974-P. Ditto, but without table 689.50

NOTE—The semi-circular base for instrument supports can be mounted on the table—not indicated in illustration.

More detailed description, with photographs of the various outfits, sent upon request.

ARTHUR H. THOMAS COMPANY

RETAIL—WHOLESALE—EXPORT

LABORATORY APPARATUS AND REAGENTS

WEST WASHINGTON SQUARE PHILADELPHIA 5, PA., U. S. A.

Cable Address, BALANCE, Philadelphia

Science

Mildred Atwood, Acting Editor — F. A. Moulton, Advertising Manager

Publications Committee

Farrington Daniels, John E. Flynn, Kirtley F. Mather, Walter R. Miles, Malcolm H. Soule, Steven M. Spencer

Vol. 107 No. 2784 Friday, May 7, 1948

CONTENTS

Centennial Celebration, AAAS—
A Preview: *Edmund W. Sinnott* 455

The National Academy of Sciences:
Abstracts of Papers Presented at 1948 Meeting 457

News and Notes 467

Technical Papers

A Coagulation Defect Produced by Nitrogen Mustard: *T. R. Smith, et al.* 474

Recovery of Pneumoencephalitis (Newcastle) Virus From the Air of Poultry Houses Containing Infected Birds: *P. D. DeLay, K. B. DeOme,* and *R. A. Bankowski* 474

High-Level Gravels of Western Grand Canyon: *Donaldson Koons* 475

The Path of Carbon in Photosynthesis: *M. Calvin* and *A. A. Benson* 476

In the Laboratory

Sodium Chlorite as an Aid in Paleobotanical and Anatomical Study of Plant Tissues: *E. S. Barghoorn* 480

Paper Chromatography Using Capillary Ascent: *Roger J. Williams* and *Helen Kirby* 481

Scientific Book Register 484

(Cover photo by A. F. Sozio, New York City.)

Science, a weekly journal, is published each Friday by the American Association for the Advancement of Science at The Business Press, Incorporated, N. Queen St. and McGovern Ave., Lancaster, Pa. Founded in 1880, it has been since 1900 the official publication of the AAAS. Editorial and Advertising Offices, 1515 Massachusetts Avenue, N.W., Washington 5, D. C. Telephone, EXecutive 6060 or 6061. Cable address, SCIMAG, Washington, D. C. Entered as second-class matter at the Post Office at Lancaster, Pa., January 13, 1948, under the Act of March 3, 1879. Acceptance for mailing at the special rate postage provided for in the Act of February 28, 1925, embodied in paragraph 4, Sec. 538, P. L. and R., authorized January 13, 1948.

Articles offered for publication should be sent to the Editor. The AAAS assumes no responsibility for the opinions expressed by contributors. Membership correspondence for the AAAS should be sent to the Administrative Secretary.

Annual subscription, $7.50; single copies, $.25; foreign postage (outside the Pan-American Union), $1.00 extra; Canadian postage, $.50 extra. Remittances and orders for subscriptions and single copies should be sent to the Circulation Department, AAAS, North Queen Street and McGovern Avenue, Lancaster, Pennsylvania, and 1515 Massachusetts Avenue, N.W., Washington 5, D. C. Claims for missing numbers will not be allowed if received more than 60 days from date of issue. No claims allowed from subscribers in Central Europe, Asia, or the Pacific Islands other than Hawaii or because of failure to notify the Circulation Department of a change of address or because copy is missing from the files.

Change of address. Four weeks notice is required for change of address. This should be sent to *Science*, 1515 Massachusetts Avenue, N.W., Washington 5, D. C. When ordering a change, please furnish an address stencil label from a recent issue. Address changes can be made only if the old as well as the new address is supplied.

The American Association for the Advancement of Science also publishes *The Scientific Monthly*. Subscription rates on request.

Centennial Celebration, AAAS—A Preview

Edmund W. Sinnott, *President*

THE PROGRAM FOR THE ANNUAL MEETING of the American Association for the Advancement of Science for 1948, which is to be held in Washington next September, has been developed in recent months by the Centennial Policy Committee of the Association and is now nearly complete. This meeting will be unique in three respects:

First, it will celebrate the Centennial Anniversary of the Association. The year 1848 will be remembered for many events, but not the least of these was the first meeting, of what was to grow into the great organization we know today. At this meeting, held at Philadelphia in the fall of that year and lasting from September 20 to 25, about 60 papers and communications were read. The Association then had 461 members, which included all the leading American scientists of the time. It is fitting that, as the Association enters its second century, we should mark this birthday with a meeting which will be particularly memorable.

Second, it will be held in September. Many years have passed since the annual meeting was convened at any time other than the Christmas holidays, and it will be interesting to see how successful this experiment proves to be. The advantages of a Christmas meeting are numerous, but it also has certain difficulties, and many of our members have often suggested that we try some other date. The period between Labor Day and the opening of most colleges seems to be a particularly favorable one and has been chosen for the Centennial. It is particularly appropriate for such a meeting to be held in the Nation's capital, and September has the added advantage that only at this time can a large gathering be accommodated in Washington.

Third, and most important, the character of the meeting will be different from any other in the Association's history. During these four days there will be none of the usual programs, with hundreds of scientific papers presented in the sections and the affiliated societies, such as have distinguished our annual gatherings in the past, but we shall hold instead a new type of program consisting of two major parts—a series of symposia and another of addresses—both by speakers especially invited to present them.

Symposia have often been held at our meetings and seem to be a particularly appropriate sort of program for the Association to sponsor. In these days of intense specialization, when scientists must take part in the activities of a large number of societies, each devoted to the development of a single field of inquiry and research, there is a growing danger that men of science will lose sight of the progress being made in other fields than their own and thus fail to achieve that breadth of outlook which is essential for sound scientific work. In the last century this was relatively easy to gain, since science was organized more simply and possessed a much smaller body of knowledge. Today, symposia are often presented by groups of men in the same general field, but there are far too few opportunities for scientists in quite different fields to come together and discuss a common problem. In the meetings of our Association it is no longer possible to accommodate all the host of scientific men in America, who necessarily must gather at other times and places for much of the interchange of ideas which is so necessary for progress. Our meetings, however, do offer ideal opportunities for the sort of symposial programs which I have mentioned and which, in the few cases where they have been tried, have already proven very stimulating. It may be that we shall want to devote more and more of our annual gatherings to such programs and that this will prove to be one of the major services which the Association in its second century can render to the advancement of science.

For this Centennial Meeting, at least, the program will in large part consist of such symposia. Fifteen of these are being organized and will be held on the mornings of Tuesday, Wednesday, and Thursday, September 14, 15, and 16, five concurrently on each day. To each symposium three distinguished scientists, chosen from different fields, will contribute a paper. Since the subject will be approached from these diverse viewpoints, care will be taken to coordinate the three papers in such a way that they may present an integrated treatment of the topic. At the conclusion of each symposium there will be discussion and comment by several scientists chosen for their familiarity with the topic.

Among the wealth of interesting and important scientific problems it has been most difficult to select a limited number for treatment in this way, and many members of the Association will doubtless wish that the Committee had made other choices. The 15 which have been decided upon, however, are all of high significance, and their discussion by the group of scientific men who have undertaken this task should prove

a memorable event. There is no space here to mention more than a few of them. The important problem of the world's sources of energy, for example, will be discussed by authorities in the fields of atomic energy, photosynthetic energy, and petroleum. Few problems in biology are now being so actively studied as that which involves the relation of genes and cytoplasm in inheritance and development, and this will be discussed by investigators who approach it from the point of view of genetics, of biochemistry, and of cytoplasmic analysis. The question of food and nutrition will be considered by authorities in world agriculture, in the science of nutrition, and in the psychology of food habits. The great problem of human educability will be approached by an educator, a psychologist, and an authority on child development. The upper atmosphere will be discussed by an astrophysicist, a meteorologist, and a student of cosmic rays. The many manifestations of waves and rhythms in nature will be dealt with by a student of supersonics, by one of "brain waves," and by a seismologist. The 15 symposia and the men who are to take part in them will be presented briefly in successive issues of *Science* during the coming weeks.

On the evenings of these three days there will also be given a series of addresses, four concurrently on each evening, by 12 distinguished scientists. These lectures will present significant scientific problems and will particularly stress the contribution made to their solution by men from many nations, thus making evident the international character of science itself. Indeed, the theme of the Centennial, manifest in the symposia but particularly emphasized in these addresses, will be "One World of Science." In a day when there are so many disruptive influences at work in the world, surely one great service of science to mankind is to show that cooperation among men of many nations, a goal so necessary and so earnestly desired, has actually been taking place between scientists for many years and is still actively practiced. This emphasis on world unity and friendly cooperation between scientists everywhere should be one of the most fruitful contributions of the Centennial of our Association.

The choice of topics for these lectures and of the men to give them was also most difficult. They cover a wide area and will be described more fully later. "Population Problems," "The World of Isotopes," "Bird Migration," "Human Frontiers," and "Giant Machines for Research" are a few of the fields which eminent men of science will discuss. These contributions should be notable ones.

The Centennial Celebration will be opened on Monday evening, September 13, when it is hoped that President Truman will welcome the members of the Association and their friends at a great gathering. The retiring president of the Association, Professor Harlow Shapley, will deliver his address at this time and will strike the Centennial keynote as he speaks on "One World of Astronomy."

These four days will not all be spent in listening to programs. The many scientific agencies of the Federal Government and the universities in and around Washington will hold "open house" for visitors throughout the week. Every afternoon and all of Friday have been left free from formal engagements so that members of the Association and other visitors can take advantage of this unusual opportunity to meet scientists of note, to visit their laboratories, gardens, and museums, and to become more familiar with the greater center of scientific activity which our national capital now is. The leisurely pace of this Centennial week, in such contrast to the crowded and hectic days of our usual annual meetings, will give to our members and friends ample chance to meet and talk with their colleagues and thus to give and receive the intellectual stimulation which is the product of personal conference and the basic reason for all scientific gatherings.

In addition to the Association's meetings during Centennial week, there will be a considerable series of scientific programs held under the auspices of the sections and the affiliated societies in or near Washington and either before or after the general meeting.

The Centennial Meeting of the American Association for the Advancement of Science will be a great one, both as to numbers in attendance and as to character and significance. Details of program, arrangements, and accommodations will be published in due course. It is hoped that everyone who can do so will take advantage of this opportunity to participate in one of the most notable events in the history of American science.

The National Academy of Sciences:

Abstracts of Papers Presented at 1948 Meeting

Transformation of Renal Tumors of Frogs to Normal Tissues in Regenerating Limbs of Salamanders

S. Meryl Rose and Hope M. Wallingford

Smith College

(Introduced by Albert F. Blakeslee)

Normal tissues in regenerating limbs dedifferentiate and revert to an embryonic state, after which the cells grow and differentiate into new tissues. Because cancerous tissue seems to be abnormally differentiated, an attempt has been made to obtain its dedifferentiation and subsequent transformation to normal tissue. In order that former cancer cells might be recognized if they did revert to normal, frog tumors with small nuclei were transplanted to limbs of salamanders which have cells with much larger nuclei.

Small pieces of rapidly growing renal tumors from *Rana pipiens* were transplanted subcutaneously to forelimbs of *Triturus viridescens*. After the small pieces of frog tumor were established and had started to grow and invade the tissues of the salamanders' limbs, the limbs were amputated through the cancer. In all cases regeneration was normal. The regenerates, with a section of the old limb, were fixed and studied histologically. During the early stages of regeneration, when the salamander tissues were just beginning to differentiate, patches of unorganized frog cells were observed. In slightly later stages patches of frog muscle, cartilage, and fibrous connective tissue can be seen interspersed and blending with the corresponding salamander tissues. The frog tissues, in addition to having smaller nuclei, were found to stain somewhat differently and are invaded by leucocytes of the host. Most of the patches of normally differentiated frog tissue are adjacent to unchanged tumor remaining in the old part of the limb proximal to the level of dedifferentiation.

Suppression and Facilitation of Angry Behavior by Certain Forebrain Mechanisms

Philip Bard and Vernon B. Mountcastle

The Johns Hopkins University School of Medicine

A state of extreme refractoriness to rage-provoking stimuli, a condition we term placidity, was produced in cats by removal of all neocortex with sparing of the remainder of the forebrain. Throughout long survival periods the animals invariably failed to show any sign of anger when subjected to rough handling or quite strong noxious stimulation. Since cats deprived of the entire forebrain tend to display rage on rather slight provocation, it is evident that in the absence of neocortex one or more parts of the remaining forebrain must continuously exert a suppressing effect upon the mechanisms in the lower portion of the brain (hypothalamus and midbrain) which are executively involved in the bodily expression of anger. This inhibitory influence is a specific one, for the placid animals showed no paucity of the many nonemotional activities of which cats without forebrain are capable. Conversion of the state of placidity to one of ferocity was effected by bilateral removal of either the cortex of the midline (gyrus cinguli and anterior limbic area) or certain parts of the so-called olfactory brain (amygdala, pyriform lobe, and hippocampus). Of a variety of restricted bilateral ablations of forebrain structures, the only one which caused a gentle normal cat to become savage was removal of amygdala and pyriform lobe. This group of experimental facts indicates that the threshold of the rage reactions of a normal animal is determined by several distinct cerebral mechanisms which interact as a series of checks and balances.

Acquisition and Maintenance of Endocrine Functions at High Altitudes

Carl R. Moore and Dorothy Price

The University of Chicago

Four species of rodents transported to, and maintained at, four altitude levels within the range of 600 feet to 14,260 feet, both as immature and mature stock, attained sexual maturity at the usual time and maintained a normal reproductive performance as adults at all altitude levels.

The fact that normal reproduction requires, within fairly close limits, a normal internal secretory function on the part of the pituitary body, thyroid glands, adrenal glands, testes and ovaries assures that normal reproductive activities provide adequate demonstration of lack of impairment of function on the part of these endocrine organs within this range of altitude.

The rat, hamster, mouse, and guinea pig demonstrate great adaptability to diminished oxygen pressures and carry on reproduction when temperature and nutrition are adequate. Altitude levels of greater than 14,260 feet are required to induce marked interference in the vital function of reproduction. Impairment of reproduction and of internal secretory functions have been reported from highland areas of other countries.

Endometrial Growth in Monkeys

Frederick L. Hisaw

Harvard University

The growth response induced in the uterine endometrium of castrated monkeys by a chronic treatment with estrogen is limited. The endometrium attains its maximal thickness within about 30 days and becomes

considerably thinner by 100 days. The growth response to estrogen is not increased when the possible influence of the muscularis is eliminated by a midventral incision through the wall of the uterus. If, however, progesterone is given concurrently with estrogen, the rate of growth is greatly increased and continues for a longer period. Also, if the muscularis is cut, the endometrium may grow out into the coelom and form an endometrial mass equal in volume to that of the entire uterus.

These effects of estrogen and progesterone also have been observed in uterine fistulas and exteriorized uteri. Endometrial growth produced by estrogen in a uterine fistula is no greater than in an intact uterus, but if progesterone is given concurrently, tongues of endometrial tissue will grow out through the fistular opening. The endometria of uteri that have been exteriorized through the abdominal wall and incised transversely from fundus to cervix show similar growth responses. This is especially true for the endometrium of the cervix which, unlike that of the anterior and posterior walls of the uterus, does not undergo cyclic blushing and blanching but remains cherry red, even during strong uterine contractions, and retains its color both previous to and during active menstruation. These preparations make it possible to observe changes in the endometrium and to obtain biopsies at frequent intervals.

The Differential Effects of Combined Radiations on Chromosome Breakage and Mutation Rate

C. P. Swanson

The Johns Hopkins University

(Introduced by B. H. Willier)

One of the important problems of cytogenetics is the relationship between chromosome change and gene mutations. The solution of the problem is difficult, particularly since the usual mutagenic agents, such as X-rays and short ultraviolet light, also alter chromosome structure. A possible avenue of approach is through the use of additional agents which, while ineffective of themselves, can, when combined with X-rays or ultraviolet, increase or decrease the rate of chromosome change without effecting mutation production, or vice versa.

Infrared, when combined with X-rays, increases the rate of chromosome change (in *Tradescantia*) and the rate of morphological mutations (in *Aspergillus*). The chromosome effect is probably due to the infrared affecting the rate of recombination of broken ends of chromosomes but not the initial rate of chromosome breakage. It is likely that the increased rate of mutations is the result of additional chromosome changes having phenotypic effects, since infrared, when combined with ultraviolet (2,537 A) is ineffective in altering the mutation rate. Infrared, therefore, does not affect the stability of the gene. Ultraviolet, when combined with X-rays, does not alter the X-ray mutation rate but markedly decreases the X-ray–induced chromosome changes.

This selectivity of radiations permits the separation of gene mutations from chromosome changes. The former result from initial absorptions of energy which are not affected by combined treatments, while the chromosome changes which depend upon initial breakage of chromosomes followed by recombination of broken ends, are influenced by additional agents which effect the recombination rather than the initial breakage phase of chromosome alteration.

Pigments of Yellow-eyed Races of Black-eyed Susan (*Rudbeckia hirta*)

Albert F. Blakeslee and Stanley G. Stephens

Smith College

The floral cone in *Rudbeckia hirta* is dark purple. Two mutants with yellow cones which are indistinguishable phenotypically are known. In one (Black Yellow) the cone is blackened; in the other (Red Yellow) it is reddened on treatment with strong alkali. Breeding tests have shown that these types have the following genetic constitutions:

Purple cone		*BY RY*
Yellow cone	(Black Yellow)	*by RY*
	(Red Yellow)	*BY ry* and *by ry*

Cones of Purple types contain a glycoside of the anthocyan pigment, cyanidin. Cones of Black Yellows contain a leuco-substance convertible to cyanidin *in vitro* by acid hydrolysis. Cones of Red Yellows contain neither leuco-substance nor cyanidin. All types contain a yellow anthoxanthin pigment of unknown constitution.

Apparently the last two steps in the production of cyanidin in Purple types are (1) production of leuco-substance by the gene, *RY*, and (2) conversion of leuco-substance to cyanidin by the gene, *BY*. When *RY* is replaced by its allele, *ry*, the first step is blocked so that neither leuco-substance nor cyanidin can be formed. The cones therefore contain only the yellow anthoxanthin pigment, which gives a characteristic deep-orange color with alkalies (Red Yellow types). When *BY* is replaced by *by* (*RY* being present), the second step is blocked, and the cones contain both anthoxanthin and leuco-substance. The mixed pigments, as also found independently in *Gossypium*, give a dark-green color (black when concentrated) with alkalies (Black Yellow types). The double recessive type, *by ry*, reacts as Red Yellow, as expected on this interpretation.

The Angiosperm Seed as a Genetic Mosaic

R. A. Brink

University of Wisconsin

The developing seed in flowering plants comprises three genetically diverse parts, endosperm, embryo, and maternal tissues. The antipodals constitute a fourth element in the pattern in species in which this tissue remains functional after fertilization. Seeds resulting from fertile matings between different species, or between diploids and their respective autotetraploids, often collapse and die before maturity. This failure is a conse-

quence of the imbalance set up between the genetically different components of the seed as a result of double fertilization by foreign rather than normal sperm. The primary changes leading to collapse occur in the endosperm. The latter structure not only is a nurse tissue to the juvenile embryo but also mediates certain necessary developmental changes in the associated maternal tissues. The endosperm in a seed destined to collapse commonly grows weakly and loses its meristematic character prematurely. Overgrowth of the adjacent maternal tissue is a frequent secondary effect of the subnormal endosperm development. Fertilization by foreign sperm in the *Gramineae* fails to evoke full activity in the persistent antipodals which lie athwart the nutrient stream. Pronounced chromosomal irregularities in the associated endosperm may ensue, thus precipitating breakdown. Death of the embryos in collapsing seeds appears to be a secondary effect of endosperm disfunction rather than a primary result of the embryo genotype. The inherent viability of such embryos has been demonstrated directly by artificial cultivation following excision from the seed. Imbalance between embryo and endosperm, although sometimes apparent, seems to be a minor factor in seed failure as compared with genetic unconformity between endosperm and maternal tissue.

Genes, Cytoplasm, and Environment in the Control of Cellular Heredity

T. M. Sonneborn
Indiana University

The view that heredity is exclusively controlled by nuclear genes is not supported by studies on cellular heredity in the one-celled animal, *Paramecium*. In this organism cytoplasm and environment, as well as genes, play decisive and interlocking roles in heredity. What hereditary traits *can* characterize a line of descent is determined by the genes; but which of the *possible* traits *will* characterize any line of descent is under the control of cytoplasmic determinants. For one group of traits, either a gene or the environment may be decisive as to whether the cytoplasmic determinant involved can survive and thereby produce the trait it determines. For another group of alternative traits, the genes seem to control the production of a series of alternative determining cytoplasmic factors or plasmagenes. Which plasmagene and trait will prevail appears to involve competition, or a sort of intracellular "natural selection," among them. The outcome of this competition is determined by specifiable past and present environmental and intracellular conditions. The preceding mechanisms operate on the cellular level of heredity, where the new cells arise from the division of cells with highly differentiated cytoplasms. Higher organisms arise from an egg with relatively undifferentiated cytoplasm, and consequently the cytoplasm ordinarily plays an insignificant role in their heredity. If the results obtained in the study of cellular heredity have any significance for higher organisms, it is probably in suggesting mechanisms, not of heredity, but of differentiation of the persistently diverse cell types that normally arise in the development of the multicellular body from the egg.

Biochemical Approach to Individuality

Roger J. Williams
University of Texas

In rare human cases unusual metabolic products are formed and excreted in significant amounts. These phenomena have been long recognized and designated "inborn errors of metabolism."

A program of investigation now under way indicates that what correspond to "inborn errors" are commonplace. Even in the early stages of the investigation, which employs microbiological, chromatographic, and spectrographic methods for analyses of body fluids, it seems clear that every individual possesses a *distinctive* "metabolic personality." By scientific means we can reasonably hope to duplicate the feat of the hound-dog, *i.e.* identify individuals by their metabolic products. Acquaintance with individual metabolic patterns will lead eventually to their effective classification.

The implications of this type of study are far-reaching because one's susceptibility to numerous diseases, including alcoholism, drug addiction, and mental disorders, is doubtless greatly influenced by his type of metabolic personality. Furthermore, significant correlations between metabolic personalities and psychological personalities will doubtless eventually appear.

Social problems of great magnitude arise out of individuality, and society must be built for real people, not hypothetical average people. In important aspects of sex, for example, normal individuals vary by a factor of 10,000-fold. In such cases a gross average is meaningless; the members of society obviously belong in several separate categories.

Only by supplementing the psychological approach with a biochemical and physiological one and by paying attention to individuality can we make a satisfactory coordinated scientific attack on the problem of human nature—a problem of unparalleled importance.

Effects of Electroconvulsive Shock on Innate and Learned Behavior in Albino Rats

Calvin P. Stone
Stanford University

Controlled experiments indicate that electroconvulsive shocks impair the learning ability of rats. The losses have sometimes been ascribed to the rat's becoming emotionally aroused because of what appears to be increasing aversion to the learning situation. However, there is temporary impairment of intellectual functions in instances wherein emotional disturbance has not been a complicating factor. Recovery is completed within two or three weeks after the course of convulsions is terminated.

Small bilateral lesions in the cortex produced by cautery are more deleterious to maze performance than electroconvulsive shocks. With complicated mazes, ablation

of from 5 to 8% of the cortex causes both more temporary and permanent impairment than a course of daily electroshocks over a period of 12–15 days.

The maternal behavior of the rats also is severely impaired by electroconvulsive shocks. When applied daily from the day of breeding to the 13th day thereafter, pregnancy is never established; but if they run from the 2nd day to the 13th day after insemination, about 30% of the females become pregnant. These carry their young to term but fail to build nests, to suckle their young, and in other ways to manifest the appropriate maternal responses. Similarly, if the course of shocks runs between the 13th day of pregnancy and the time of parturition, there is no maternal behavior whatever. When the shocks begin on the 2nd day postpartum and continue until the 15th day, variable results are obtained. Gradually, nests which have already been built begin to fall apart, any young which are dragged from the nest are not retrieved and die from neglect, and young remaining in the nest are stunted in growth. On the whole, the disturbance of maternal behavior caused by electroconvulsive shocks is more striking than that produced in the more strictly learned responses involved in maze and discrimination problems.

The Bearing of the Living *Metasequoia* on Problems of Tertiary Paleobotany

Ralph W. Chaney
University of California

A recent study of the environment and plant associates of *Metasequoia* in central China provides significant data for the interpretation of Tertiary floras, of which this genus is a member. Preliminary study of the material now assigned to *Sequoia* indicates that in many instances the fossil leaves and cones are referable to *Metasequoia*, a genus which has survived only in central China but was formerly widely distributed over the northern hemisphere.

Sucrose Utilization by the Plant

F. W. Went
California Institute of Technology

When lack of neither inorganic nutrients nor water interferes with growth of a plant, which processes are limiting or controlling its growth? In the tomato plant it was found (1) that when the light intensity drops below 1,200 f.c., photosynthesis becomes limiting; (2) that because of the peculiar temperature coefficient of sugar translocation (about 0.5, meaning that less sugar is transported upon a rise in temperature) a sugar deficit develops in the growing regions when tomatoes are grown at high night temperatures; (3) that, most actual growth occurring during night, growth is controlled by the night temperature. At low night temperatures (below 15° C) the growth process is slowed down so much that it limits growth, and neither hormone nor sugar applications can increase the growth rate.

Since it was found that sucrose sprayed on leaves of tomato plants is readily absorbed, from points (1) and (2) it can be concluded that sugar sprays will be effective in increasing growth under conditions of low light intensity and high temperature. This is exactly what was found experimentally. But at low temperatures, especially during night, utilization of the photosynthesized sugar is limited by the slow growth process. This is the usual condition of field-grown plants, which means that the apparent photosynthetic efficiency of plants in nature is very low.

A thorough knowledge of the physiology of crop plants may very well increase their photosynthetic efficiency by increasing their rate of sugar utilization. The dry weight and fruit production of tomato plants, for instance, can be increased several fold by darkening them each afternoon during the spring season. Under those conditions the photosynthates are used much more efficiently.

The Role of the Spleen in the Quinine Treatment of Malaria

W. H. Taliaferro, L. G. Taliaferro, and F. E. Kelsey
The University of Chicago

A standard quinine dosage administered to chickens infected with *Plasmodium gallinaceum* was less effective in reducing mortality and parasitemia in splenectomized than in intact chickens. We have found no evidence that the spleen (or the macrophages which it contains) plays any direct role in the chemotherapeutic activity of quinine by virtue of its role in immunity, its metabolic activity, or its localization of the drug. Thus, quinine does not stimulate phagocytosis of parasites by the macrophages of the spleen, liver, and bone marrow. As these are the macrophages chiefly involved in the suppression of infection during innate and acquired immunity, quinine does not act by stimulating the immune mechanism. Quinine apparently acts as such and is not transformed in the body to a more active product. Its chief action is to inhibit the reproduction of the parasite. Splenectomy raises the quinine blood level after a standard dose of drug, and this results in a more effective drug-parasite contact.

Further analysis indicates that three independent antimalarial factors are operative during quinine treatment, viz., innate immunity, acquired immunity, and the antimalarial action of quinine. Splenectomy produces its chief effect by reducing the auxiliary action of acquired immunity. The loss of acquired immunity reduces the overall antimalarial action to such an extent that the probably increased drug action, as indicated by the increase in quinine blood level in splenectomized chickens, is obscured.

Tuberculosis in Germany

Esmond R. Long
University of Pennsylvania

A rise in tuberculosis is a usual aftermath of war and disaster. Germany experienced such a rise after each World War. With the outbreak of World War II, a

previously excellent tuberculosis control program deteriorated rapidly, and by the end of the war conditions were chaotic. Malnutrition and inadequate hygiene paved the way, and crowding, utilization of German tuberculous patients in industry, and the exodus of tuberculous inmates of concentration camps at the end of the war resulted in dissemination of the disease.

After the war, a control program was rapidly revived by newly constituted public health officials with the assistance of the Military Government in the U. S. Zone, and supported by reallocation of beds for tuberculosis, reorganization of out-patient clinics, search for qualified personnel, and new organization of the reporting system for cases. Substantial improvement has taken place in the last two years, and the mortality rate has returned to the prewar level in most of the Zone.

In the city of Berlin restoration to normal has proceeded slowly. The tuberculosis mortality rate is four times that in the U. S. Zone. The excessive rate is the result of a number of factors, including Berlin's disadvantageous position with respect to housing, food supply, and beds for the care of tuberculosis. Some improvement is now evident.

Continued progress is contingent upon political and economic stability, making long-range planning possible.

A New Instrument for Measuring the Thermal Radiation of the Environment

James D. Hardy and Charles H. Richards
Cornell University Medical College
(Introduced by Eugene F. DuBois)

To determine the total heat load on the human body out-of-doors it is necessary to measure the air temperature and velocity, humidity, and total thermal radiation. Adequate methods are available for measuring humidity, air movement, and temperature, but due to the lack of a proper instrument, information regarding the thermal radiation of the environment is extremely meager. Heat radiation incident upon a man out-of-doors includes that from the sun received directly and reflected from surrounding objects, as well as infrared radiation exchange to and from the surroundings and sky.

To measure the sum of radiation from all these sources we have constructed an instrument which is portable and which can give readings at approximately 2-min intervals. The apparatus consists of two hollow silver spheres 6 mm in diameter, one of which is highly polished and the other blackened. Both spheres contain small heating coils and thermocouples. Electrical energy is put into one or the other sphere to bring them to the same temperature. When the black sphere is receiving radiation from the environment, energy must be put into the polished sphere, and the amount of this energy is equivalent to the difference in the radiation received by the two spheres. When there is a loss of heat by radiation, as, for example, at night, energy is put into the blackened sphere. Data so obtained must be corrected for reflecting power of the skin and clothing in different parts of the spectrum.

Measurements of total radiation with this instrument were made in New York City in summer and winter. These indicated that at 34° C (ordinary skin temperature) in summer a body absorbed radiant heat at a rate of 100 kcal/m²/hr when in the direct sunlight. Under the same conditions in winter there was a loss of heat at a rate of about 50 kcal/m²/hr. This difference in radiation is due to change in temperature of the surrounding objects from summer to winter.

An Interference Method for the Study of Diffusion

L. G. Longsworth
The Rockefeller Institute for Medical Research

When a boundary, in which a solute is diffusing from the solution underneath into the solvent above, is placed in the path of a lens, the image of an illuminated horizontal slit is spread out into a rectangular pattern of interference fringes. This phenomenon was first observed and explained qualitatively by Gouy in 1880. The lower edge of the rectangle is formed by light that suffers a maximum downward deflection in passing through the layer of solution at the center of the boundary, where the gradient of refractive index is steeped. The interference fringes are formed by rays that pass through layers of equal gradient above and below the center of the boundary, for which the path difference is such as to give constructive interference.

As diffusion proceeds and the boundary spreads, the rectangle of light contracts, without alteration of the number of fringes, by the upward movement of its lower edge. Although previous workers have used this motion to follow the diffusion process, because of diffraction effects this edge is not sharply defined and its location is difficult. The fringes, on the other hand, can be located accurately, and, with the aid of the theory of their spacing recently developed by Kegeles and Gosting, any fringe may be used for the evaluation of a diffusion coefficient. The precision of the method is further enhanced by averaging the results from a large number of the fringes.

Reaction Rates in Physics

Henry Eyring
University of Utah

A general expression for the rate of change, R, of a system can be written as $R = \Sigma_i\ n_i\ \nu_i\ \gamma_i$ where n_i is the number of systems in the ith state; ν_i is the frequency of vibration along the reaction coordinate, and γ_i is the chance of a reaction occurring during each vibration. Nuclear decompositions have been considered by Condon and Gurney and by Gamow, as well as by others, from this point of view. There are now many types of nuclear reactions. The Richardson equation treats thermal emission of electrons. In this case, n_i is calculable from known equilibrium theory with the usual uncertainty about the magnitude of the activation energy, which in this case is the work function. Electrical and thermal

conductivity of metals are well understood in principle. Thermal conductivity of nonmetals still offers difficulties.

Diffusion and viscosity of liquids have been systematized by treating them as examples of reaction rates involving the jumping of molecules from one equilibrium position to another. For this to occur, an empty site must be provided, and the associated activation energy is chiefly the energy required to provide such an empty site. This free energy has been related to the heat of vaporization. The formal theory is a straightforward adaptation of the formalism of chemical kinetics. Dielectric relaxation is treated in the same way.

Deformation of solids was treated by Maxwell as the stretching of springs attached to dashpots. The latter were assumed to relax at a rate proportional to the force. This oversimplification has been rectified by treating dashpot relaxation as one would a chemical rate process. The rate of relaxation is thus found to depend exponentially on the force, as is required by experiment. One of the key problems in plastic deformation is to know to what extent n_i (the number of flow units in various states) can be calculated from equilibrium theory and how much the n_i are "frozen in" imperfections. The equilibrium theory leads to a picture of fluctuations in density responsible for flow in metals much like the fluctuation responsible for the blue of the sky. The arguments for this point of view will be briefly summarized.

Reaction Rates in Chemistry

Hugh S. Taylor

Princeton University

Arrhenius developed the empirical equation for reaction rates in chemical processes, $k = A \exp.(-E/RT)$ in terms of active and normal molecules in equilibrium with one another. Thirty years ago the factor A was interpreted as a "collision number," Z, for spherical molecules. Deviations caused the insertion of a "steric factor," P, to yield an equation $k = PZ \exp.(-E/RT)$ for abnormal rates of reaction. When P was found to vary from 10^{-1} to 10^{-8} in "slow" reactions, the concept of a steric factor became indefinite. Eyring, Polanyi, and their co-workers developed a theory of absolute reaction rates which not only interpreted A of the Arrhenius expression but set forth the concept of the activation energy, E, in terms of a potential energy barrier separating reactants and products. The rate was determinable in terms of the concentration of an activated complex at the top of the potential energy barrier, which concentration was calculable by statistical mechanical procedures. The velocity constant was expressible by the equation

$$k = \frac{RT}{Nh} \exp.(-\Delta F'/RT) = \frac{RT}{Nh} (\exp. \Delta S'/RT) \exp.(\Delta H'/RT),$$

in which the free energy of activation, $\Delta F'$, the entropy of activation, $\Delta S'$, and the heat of activation, $\Delta H'$, of the activated complex are explicitly introduced. The equation shows that the collision theory, $k = Z(\text{exp. } E/RT)$, is limited to reaction between two hard spheres. The p factor takes account of the entropy change in activation.

The influence of surfaces in accelerating reactions was formulated by Langmuir in terms of monolayer adsorption on a uniform surface. It can now be shown that actual reactions on surfaces are complex in their nature, since most surfaces are nonuniform, and the rate processes may be governed by the chemisorption of reactants, which may be slow, by rearrangement on the surface or by desorption of the reaction products. New evidence for surface heterogeneity is presented.

Reaction Rates in Biological Processes

Frank H. Johnson

Princeton University

Biological phenomena are generally dependent upon numerous and complex reactions, ultimately limited by the activity of protein catalysts, or enzymes, with their substrates. Frequently a single enzyme system is largely rate determining. In bioluminescence the luciferin-luciferase oxidative system itself limits the rate under an unusually wide variety of conditions, and the intensity of the emitted light furnishes a unique, instantaneous index to its activity. Normally, two reactions involving the same molecule, the enzyme luciferase, govern the observed result: (1) an equilibrium (K_1) between active and inactive states of the protein, and (2) the catalytic reaction with specific rate constant (k_2). Thus, with other factors constant, the quantitative relation between the brightness (I) of bacterial luminescence and temperature (T) as well as hydrostatic pressure (p) is described by equation (1), in which the equilibrium constant is defined in the usual manner, the rate constant by the Theory of Absolute Reaction Rates (Eyring), and "b" is a proportionality constant:

$$I = \frac{b\, k_2[\text{luciferin}]\,[\text{luciferase}]}{1 + K_1} = \frac{\frac{kT}{bkh}\overline{K}^{\ddagger}\,[\text{luciferin}]\,[\text{luciferase}]}{1 + K_1} = \frac{cTe^{\frac{-\Delta E^{\ddagger} + p\Delta V^{\ddagger}}{RT}}}{1 + e^{\frac{-\Delta E + p\Delta V - T\Delta S}{RT}}}. \quad (1)$$

The equilibrium (K_1) has the large energy (ΔE), volume change (ΔV), and entropy (ΔS) of reaction indicative of protein denaturation. The rate process (k_2) has the moderate activation energy ($\Delta E^{\ddagger}$), typical or biological oxidations, and a fairly large volume increase of activation ($\Delta V^{\ddagger}$). Thus, K_1 is more strongly influenced by temperature than k_2. Consequently, the observed rate increases with rise in temperature, then goes through a maximum, and finally decreases, as in most other biological processes. Likewise, since ΔV is larger than $\Delta V^{\ddagger}$, the influence of pressure depends upon the temperature, and vice versa. Pressures of a few hundred atmospheres

may strongly retard, have no effect, or greatly accelerate the process at low, optimum, or relatively high temperatures, respectively.

The large volume increases probably indicate an unfolding of the protein, in both the denaturation and the catalytic reaction. In growth, similar volume changes may be expected to accompany the formation of biologically specific molecules, such as genes, viruses, and proteins, by the templet mechanism generally, the first molecule acting as a pattern for the synthesis of a second one just like it. To serve as a templet it would seem necessary for a globular protein first to unfold into a fibrous form, probably with a volume increase. Thus, although equation (1) has been found to describe the rate of bacterial (*E. coli*) reproduction at normal pressure, growth is strongly retarded under 500 atm, regardless of temperature. Reproduction of a large variety of bacteria (except among certain barophilic organisms from the deep sea) is virtually prevented by pressure of the same magnitude.

A drug or other chemical (X), e.g. sulfonamides, may reversibly inhibit the luminescent process by combining with the enzyme independently of the denaturation equilibrium (K_1) through an additional equilibrium (K_2). A different type (U), exemplified by alcohol, ether, urethane, etc., combines in a manner that furthers the denaturation through still another equilibrium (K_3). In both cases the net result is governed by temperature and hydrostatic pressure as well as by the concentration of the inhibitor, in accordance with equation (2):

$$I = \frac{\frac{eTe}{1} \quad \frac{\Delta E^{\ddagger} + p\Delta V^{\ddagger}}{RT}}{+K_1 + K_2(X)^r + K_1K_2(X)^r + K_1K_3(U)^s}. \qquad (2)$$

With the numerical values of the constants determined from experiments, the relative rate of the process may be calculated with considerable success for the different values of the variables concerned. Equation (2) also describes with some accuracy the rates of aerobic and anaerobic glucose oxidation by certain bacteria in the presence of urethane at various temperatures.

The theory arrived at through the study of luminescence has anticipated results in other connections and has contributed toward an understanding of the fundamental mechanism of rate control in processes of greater and less complexity than luminescence, including growth, muscle contraction, extracted enzyme reactions, specific antibody precipitation, killing of bacteria and spores, denaturation of viruses, and others.

Reaction Rates in Solids

Frederick Seitz
Carnegie Institute of Technology

Reactions in solids involving the motion of atoms represent special cases of chemical reactions in general and as a result can be formulated in terms of the methods developed by Wigner and Eyring to treat reaction rates. Several important types of reactions are discussed on the basis of this formalism, namely, chemical diffusion, plastic flow under stress, nucleation of phase transformations, and grain growth. Of the reactions considered, diffusion is the most basic, since it is involved, at least as a connecting link, in all reactions in solids other than those which depend only upon a change in electronic configuration. As a result, principal attention is devoted to it. Diffusion can occur by means of either one of three basic geometrical paths, namely, by direct interchange of atoms, by interstitial migration, and by migration of vacant lattice sites. The mechanism which may occur in any given system depends upon the activation energy required for each of the three geometrical possibilities, that requiring lowest energy being preferred. The experimental and theoretical information that is available concerning the mechanism which obtains in the various types of solids is discussed. Direct interchange appears to be forbidden in almost all cases, whereas interstitial and vacancy diffusion occurs commonly in many familiar solids. The role of diffusion in reactions involving solids is surveyed.

Observing the Phases of Light Waves

F. Zernike
The Johns Hopkins University

The phases of light vibrations cannot be observed. The fringes in the diffraction pattern of a slit, for example, must alternately have reversed phases, but are all seen alike. By projecting this pattern on an evenly illuminated background, however, those fringes that have phases opposite to the background show dark, the others light, thus revealing their phases. Evidently this is an interference phenomenon to be observed only if the background is coherent with the pattern. Different ways of obtaining this are discussed and the results shown.

An application of greater general interest is found in the phase contrast method. A light wave that has passed through a slightly inhomogeneous medium, such as the air flowing around a model in a wind tunnel, has local differences of phase. The classical way of observing these is by the use of an interferometer. In the phase contrast method, the comparison wave which forms the background is obtained in a simpler way by diffraction at a narrow transparent strip. Small changes in phase appear in this way as differences of intensity. Comparable circumstances are found on a smaller scale in microscopic observation of transparent objects. Details of the newest development of this phase microscopy are given and some results shown.

The Energy Source for Light Emission in Fireflies

William D. McElroy
The Johns Hopkins University
(Introduced by E. V. McCollum)

When a water extract is made of firefly "lanterns," a preparation is obtained which is momentarily highly luminous; however, upon standing the light rapidly disappears. The light emission is presumably due to an oxidation of the substrate molecule (luciferin) in the presence of an enzyme (luciferase). According to pre-

vious ideas, the substrate molecule of this reaction is destroyed during light emission. An alternative explanation based upon the source of energy necessary for luminescence has been suggested for this "irreversible" step in the light reaction. In recent experiments on firefly extracts it has been possible to demonstrate that the energy necessary for light production is the limiting factor in luminescence and that this can account for the apparent irreversibility of the light reaction. If energy is supplied to the firefly extract in the form of high-energy phosphate groups (adenosine triphosphate), a brilliant flash of light appears immediately which is maintained for a considerable time in proportion to the ATP concentration. It appears that the light-emitting reaction is "re-established" by the transfer of high-energy groups from the ATP molecule to some component of the light-emitting system, presumably luciferin.

The results demonstrate an additional use of metabolically generated energy-rich phosphate groups in a biological system and support the general principles concerning the liberation and transfer of energy in the form of small, discrete units. It would appear that the simple oxidative step in light production is only the last step of a series of reactions leading to excitation of the luciferin molecules. Reactions prior to light emission are apparently necessary to meet the energy requirements.

Detection of Short-Range Particles From Nuclear Disintegrations by Means of an Electron Multiplier Tube

Samuel K. Allison
The University of Chicago

The electron multiplier vacuum tube is an amplification device whose action depends on the fact that electrons or heavier ions, striking a metal surface properly prepared, eject secondary electrons. More than one such secondary is emitted per ion, and if these secondaries all strike a second plate, the shower is amplified. In a 12-element tube developed by J. S. Allen and used by us, 7×10^5 electrons arrive at the 12th plate for one electron striking at the first. Many artificially produced nuclear reactions take place in high vacuum when a beam of high-energy ions impinges on a target. In detecting the disintegration products of such a reaction, the produced particles previously had to pass through the vacuum wall of the system, and the existence of particles of low penetrating power, unable to do this, could not be directly proved. With the electron multiplier tube we can detect and study the slow recoil nuclei. The technique may be compared to the study of gunnery by careful measurements on the recoil of the gun tube rather than by following the flight of the projectile. We have detected the lithium nuclei recoiling from the reaction $Be^9(p,\alpha)Li^6$ and found that they occur in the three possible states of ionization. The recoiling light helium nuclei from $D^2(d,n)_2He^3$ have been measured, giving a new value for the energy of the neutrons, which are difficult to measure accurately. By allowing the lithium nuclei, produced as above, to pass through thin foils, it is possible to measure their rate of loss of energy and study the probability that the atomic fragments will pick up or lose an electron in the interesting region where the velocity of the moving fragment is comparable to the orbital electronic velocities.

New Vacuum-Tube Developments

A. W. Hull
General Electric Company

Three new vacuum-tube developments are described. The first is an efficient, long-life cathode for thyratrons, called a *dispenser cathode*. Its electron emission remains constant during life, which may be many years, and it is uninjured by overloads and short circuits. Experimental cathodes have been made for currents as high as 5,000 amp.

The second new tube is a high-voltage thyratron, for rectifying and controlling currents at high voltages. The high-voltage quality is obtained by insulated grids, mounted between the control grid and anode, which multiply the operating voltage in proportion to their number. An experimental tube with 5 grids, which controlled 40 amp at 70 kv, is described. Possible applications are power supply for television transmitters and direct-current power transmission.

The third new tube is a rectifier which uses cesium both as coating for the hot cathode and as current-carrying vapor. This double use of cesium gives the highest efficiency theoretically obtainable in a thermionic rectifier, combined with unlimited life. Applications include changing alternating current to 110-v direct current.

Experiments With High-Speed Rotors

J. W. Beams
University of Virginia

The technique previously described (Beams, Young, and Moore. *J. appl. Phys.*, 1946, **17**, 886) for spinning steel and other ferromagnetic rotors to high speeds in a vacuum has been improved. The rotors are suspended magnetically and spun by a rotating magnetic field arrangement. With the air or gas, in the chamber surrounding the spinning rotor, at a pressure of 10^{-6} mm Hg, practically all of the frictional drag is accounted for by gaseous friction alone. As a result, the power required to drive the rotor in a high vacuum is very small, and the maximum rotational speed obtained is limited only by the strength of the rotor. Rotors weighing from 5.0×10^{-4} to 10^4 gm have been used.

With a 21-mil-diameter steel rotor, centrifugal fields of 4.3×10^8 times gravity were obtained with a rotor speed of 6.33×10^5 r.p.s. The low frictional drag also makes it possible to drive the rotor in synchronism with a piezoelectric-crystal controlled circuit without "hunting." This should give rotor speeds constant to one part in 10^8. Symmetrical magnetic stainless steel mirrors are found to be well adapted for rotating mirror experiments. The application of the technique to certain centrifuging problems is outlined.

The Gas Turbine and Its Significance as a Prime Mover

C. Richard Soderberg
Massachusetts Institute of Technology

The gas turbine is the fourth of the major prime-mover developments of a century and a half, the other three being the steam engine, the steam turbine, and the internal combustion engine. An early contender in this race, the hot-air engine, failed to reach maturity but contained the basic idea out of which the recent gas turbine developments have grown. This paper gives a brief survey of this development and its significance.

Trajectories and Conics

Edward Kasner
Columbia University

John De Cicco
Illinois Institute of Technology

In the Newtonian field the trajectories are conics, and simple results arise. In general fields of force, the trajectories (paths of free particles) are complicated. The authors use conics which have highest contact with the curves at a given point, and new general theorems are found.

If we start at a fixed point in a fixed direction, the single infinitudes of trajectories have osculating conics whose *centers always lie on a straight line.*

If we study catenaries, brachistochrones (least time), and other physical families, the locus of centers of the conics is found itself to be a conic (ellipse, parabola, or hyperbola).

Two Academy Conferences on Theoretical Physics

J. Robert Oppenheimer
Institute for Advanced Study

The National Academy of Sciences has sponsored and supported two small conferences on fundamental problems of theoretical physics. The first was held at Shelter Island in early June of 1947; the second, in the Poconos in early April of 1948. Among the many problems discussed, three were most intensively considered at both conferences: (1) the relation of mesons with nucleons; (2) the electromagnetic properties of nuclear matter; and (3) the development of electrodynamics to form a consistent theory, and the comparison with experiment of its prediction for the reactive corrections in atomic phenomena.

The rapid progress of the last year tended to confirm the earlier conclusions that (a) the paradoxes of electrodynamics were far less serious, and its range of validity far greater, than had long been supposed; (b) far less was known of the essential experimental facts about mesons than imagined; and (c) the unambiguous detection of specific interactions between nuclear matter, on the one hand, and electrons and radiation, on the other, may require a careful analysis of the finer points in the quantum theory of interacting fields. In the course of the discussion there was speculation about the synthesis of these various areas of experience in the atomic world.

The members of the conference wish to express their great gratitude to the Academy.

Thermochemistry of Ferromagnesium Silicates

Th. G. Sahama
Geophysical Laboratory
Carnegie Institution of Washington
(Introduced by L. H. Adams)

As an example of the application of thermochemistry to petrology and mineralogy, the simple ferromagnesium silicates, occurring as olivines and orthopyroxenes in rocks, were investigated. The heats of solution in hydrofluoric acid were measured by means of a solution calorimeter constructed for the purpose. A linear relationship was found between the heat of solution and the iron magnesium ratio of the mineral, indicating that the iron magnesium replacement in the structures of these minerals is thermally perfect. The importance and possibility of applying calorimetry to the study of the complicated replacement phenomena in rock-forming minerals is emphasized. On the basis of the results obtained, the stabilities of $MgSiO_3$ and $FeSiO_3$ are illustrated.

Hydrothermal Silicate Equilibria

N. L. Bowen and O. F. Tuttle
Geophysical Laboratory
Carnegie Institution of Washington

The accessible part of the solid earth is composed largely of silicates, but molten material from which igneous rocks consolidate is not a simple molten mixture of silicates. In addition to these very refractory substances it contains small amounts of substances which not only melt but even boil at comparatively low temperatures. They are, therefore, commonly referred to as the volatile components. They remain dissolved in the silicate melt or magma in the depths only by virtue of the high pressures that prevail there. Their violent escape when magmas approach the surface is a cause of the explosive phases of volcanic activity. If the magma crystallizes slowly under deep-seated conditions, they are in part retained, to enter into the composition of some of the crystalline *igneous* minerals, and in part they may escape into surrounding rocks and bring about the formation of *metamorphic* minerals.

Analyses of the gases that escape from volcanoes and of the minerals that form in and about plutonic igneous masses show that water is the most important of the volatile components. Experimental investigation designed to throw light on the origin of rocks must, therefore, include studies of phase equilibria in silicate melts containing water and of the equilibrium relations of water with crystalline silicates. High pressures as well as high temperatures are required in such investigations. We present some results obtained in melts of the system K_2O—Al_2O_3—SiO_2—H_2O, representing igneous condi-

tions, and others for compositions of the system MgO—SiO_2—H_2O, representing metamorphic conditions. In the investigations pressure up to 30,000 lbs/sq in combined with temperatures up to 900° C were employed.

Nuclear Reactions, the Intermediate or Compound Nucleus, and Continuity of Series

William D. Harkins
The University of Chicago

In 1919 Rutherford disintegrated the nuclei of nitrogen by collisions with fast helium nuclei and assumed that the nucleus was split into carbon and hydrogen by the blow. The reaction assumed was a noncapture disintegration: $_7N^{14} + _2He^4 \rightarrow _6C^{13} + _1H^1 + _2He^4$.

The writer considered that a photographic process was essential to determine the mechanism and in 1923 published with R. W. Ryan a method by which, by the use of α-particles of a velocity of 20,600 km/sec and by the first use of the cloud chamber of C. T. R. Wilson for this purpose, this could be revealed. The Chicago method was adopted at Cambridge, and in the few cases photographed the α-particle was captured.

Whereas the experimental results obtained at Cambridge and Chicago were identical, their interpretations were entirely different; at Cambridge disintegrations by noncapture of the projectile were considered possible as late as 1935.

The theory developed at Chicago (Proceedings of the Academy, 1926 and 1936) considered that below the highest energy then known (14 Mev) noncapture disintegrations do not occur. The primary event is not a disintegration but a synthesis of a nucleus, as, for example,

$$_7N^{14} + _2He^4 \rightarrow _9F18^* \; He^4.$$

The intermediate fluorine nucleus, after a life period, disintegrates in any one of several ways.

Until 1936 this theory was considered "*impossible*" by *theoretical nuclear physicists.*

In the reactions of the atomic bomb it is not uranium 235 which fissions, but only the intermediate or compound 236, formed by the addition of a neutron. This provides as much energy as 1,500 tons of coal from 1 lb of U_{235}.

The present paper considers more recent work: the extension of the relations into the region of 100,000,000 electron volts.

Microwave Spectroscopy and Molecular Structure

E. Bright Wilson, Jr.
Harvard University

Microwave spectroscopy now provides one of the most precise and definite methods of determining the structures of molecules of not too large a size or too complicated a nature. Because of the exceedingly high resolving power and great measurement precision possible in this region as compared with that in the infrared, it is possible in the microwave region to resolve the pure rotational spectra of many molecules whose vibration rotation bands in the infrared are quite unresolvable. The possibility of observing isotope shift, Stark and Zeeman effects, and hyperfine structures due to nuclear quadrupole moments adds further power to this tool. The most difficult part of the utilization of the microwave spectra is the analysis, unless the molecule is linear or symmetrical. It is at present a very laborious process to analyze the spectrum of an asymmetric rotor-type molecule. Nevertheless, many tools are available which can be used in this problem of analysis. The information which can be obtained from a completely analyzed spectrum is discussed along with some of the difficulties and methods for getting around these difficulties. Several molecules which have been studied recently are used as examples.

At the annual dinner of the Academy held in Washington, D. C., April 27, the Henry Draper medal for 1947 was conferred on Hans A. Bethe, professor of physics at Cornell University, in recognition of his contributions to astronomical physics and more especially his researches on the generation of energy in the sun and stars.

The Charles Doolittle Walcott bronze medal and award for 1947 went to Alexander G. Vologdin, a corresponding member of the Academy of Sciences and a distinguished scientist of the Paleontological Institute in Moscow. Dr. Vologdin was selected because of his studies of Pre-Cambrian and Cambrian algae and particularly because of his researches on that most distinctive and enigmatic group of Cambrian organisms, the *Archaeocyatha*.

The Agassiz gold medal and honorarium for 1947 went to Felix Andries Vening Meinesz, professor of geodesy and geophysics, University of Utrecht, and president of the Netherlands Geodetic Commission, for his contributions to oceanography. Professor Vening Meinesz is known for his invention of an apparatus for the determination of gravity at sea, his many measurements of gravity in each of the great oceans, and his interpretation of the physical properties and behavior of the earth's crust beneath and adjacent to the oceans.

NEWS and Notes

Distinguished scientists, educators, and business leaders assembled at 420 East 68th Street, New York City, on April 16 for the opening of the new Sloan-Kettering Institute for Cancer Research. Contributions totaling $4,562,500 from Alfred P. Sloan, Jr., chairman of the Board of Directors of General Motors, has made possible the construction of a completely modern 14-story research building (see cover) which is joined with a great cancer hospital (Memorial), a teaching center, a prevention-detection clinic (Strang), as well as with a city cancer hospital (Ewing) now under construction. Under the direction of C. P. Rhoads, the center will operate as a great national cancer center, financed through voluntary contributions of the public and such other grants as are available.

The morning session included an address by Sir Henry Dale, a Fellow of the Royal Society and its president from 1940 to 1945; informal discussions in the various laboratories; and the formal dedication ceremonies. A series of panel discussions took place in the afternoon, the theme being Participation in Medical Research by Universities (James B. Conant, president, Harvard University; Harry Woodburn Chase, chancellor, NYU; Edmund E. Day, president, Cornell University); by Technology (Karl T. Compton, president of MIT; Paul Aebersold, Atomic Energy Commission; William D. Coolidge, General Electric Company; George W. Merck, president of Merck & Co.); by Government (Leonard A. Scheele, Surgeon General, USPHS; Herman E. Hilleboe, New York State Commissioner of Health; J. Donald Kingsley, Assistant Federal Security Administrator; A. N. Richards, president of the National Academy of Sciences); and by the Layman (James S. Adams, co-chairman of the Executive Commission of the American Cancer Society; Albert D. Lasker, president of the Albert and Mary Lasker Foundation; Philip T. Sharples, president of the Sharples Corporation).

At a dinner at the Waldorf-Astoria that evening, with Reginald G. Coombe, president of Memorial Hospital presiding, the speakers included Sir Henry Dale, Charles F. Kettering, vice-president and director of research for General Motors, and Director Rhoads. At the conclusion of the dinner Mr. Coombe presented the Katherine Berkan Judd Awards ($1,000) for outstanding contributions to the advancement of cancer research during 1947 to Alexander Haddow, director of the Chester Beatty Research Institute, Royal Cancer Hospital of London, and Eric Boyland, professor of biochemistry, University of London.

About People

Neil E. Gordon, professor of chemistry at Wayne University, was honored at a dinner at the Hotel Stevens, Chicago, April 20, during the meetings of the American Chemical Society, for his contributions to chemistry and related sciences made possible by his organization of the well-known Gibson Island Research Conferences in 1938. At the ceremony the Conferences were renamed the Gordon Research Conferences. A description of the background of these Conferences and the program for the sessions to be held from June 21 to September 3, 1948, have recently been published (*Science*, March 26, pp. 308–312). Dr. Gordon was organizer and former editor of the *Journal of Chemical Education* and is currently editor of *Record of Chemical Progress.*

E. Duncan Grizzell, professor of education at the University of Pennsylvania, has been elected dean of the School of Education there, to succeed **John H. Minnick,** who will retire on July 1. Dr. Grizzell, a faculty member at Pennsylvania for 27 years, served from 1926 to 1946 as chairman of the Commission on Secondary Schools of the Midlle States Association of Colleges and Secondary Schools. He has studied educational practices in England, France, Italy, and Switzerland, and in 1944 he served on a commission which the Department of State sent to Bolivia to survey the state school system there. Since 1945 he has been a member of the advisory committees to the Divisions of Secondary Education and International Educational Relations of the U. S. Office of Education.

Francis Daniels Moore, a 34-year-old surgeon, has been named surgeon-in-chief of the Peter Bent Brigham Hospital and Moseley professor of surgery at the Harvard Medical School. A graduate of Harvard College and Harvard Medical School, his interests lie in the field of general surgery and in the relation of the autonomic system to the stomach and intestine. During and after the war Dr. Moore carried out studies on the care of burned patients, working with other doctors under the Office of Scientific Research and Development. Much of this work was accomplished through the use of radioactive isotopes, and in the past two years Dr. Moore has continued to study the use of isotopes in surgical research.

George E. Pake, a National Research Council Predoctoral Fellow at Harvard University, **C. Sharp Cook,** of the Department of Physics, Indiana University, and **Franklin B. Shull,** Eastman Kodak Fellow in the Physics Department, University of Michigan, have recently been appointed assistant professors of physics at Washington University, St. Louis.

John R. Heller, chief of the Venereal Disease Division, U. S. Public Health Service, has been appointed director of the National Cancer Institute. He will replace **Leonard A. Scheele,** who recently became Surgeon General of the U. S. Public Health Service.

Charles R. Naeser has been named executive officer of the George Washington University Chemistry Department, a position formerly held by **Benjamin D. Van Evera**, who is now on part-time loan to the National Research Council, where he is serving as secretary of the Fellowship Office.

L. O. Weaver has joined the staff of the Department of Botany, University of Maryland, as assistant professor of plant pathology. His major work at Maryland will be with tree fruit diseases. Dr. Weaver has recently occupied a similar position at Pennsylvania State College.

Carleton S. Coon, professor of anthropology at Harvard University, has been named professor of anthropology and curator of ethnology at the Museum of the University of Pennsylvania, effective July 1. Dr. Coon has done extensive field work in North Africa, the Balkans, Ethiopia, and Arabia. It was on an expedition to North Africa in 1939 that Dr. Coon found remains of Neanderthal Man.

Howard Robinson, professor of history at Oberlin College and head of the Department since 1941, has been appointed acting dean of the College of Arts and Sciences, effective May 1. Dr. Robinson succeeds **Carl Wittke**, who resigned recently to become dean of the Graduate School of Western Reserve University.

Hugo Martin Krueger, of the American University of Beirut, Lebanon, has been appointed professor of physiology at Oregon State College to replace **Rosalind Wulzen**, who retires June 30. Dr. Krueger's fields of specialization are respiration, anaphylaxis, and the physiology of the gastrointestinal tract.

W. C. Hueper, formerly assistant director and principal pathologist of the Warner Institute for Therapeutic Research, New York City, has been appointed chief of the newly created Environmental Cancer Section at the National Cancer Institute, Bethesda, Maryland.

George D. Rock, professor of physics at Catholic University, Washington, D. C., has been named dean of the Graduate School of Arts and Sciences to succeed **Edward J. Finan**, who has resigned because of ill health. Dr. Finan will remain on the faculty as a professor of mathematics.

Joseph T. Roberts, formerly chief medical officer at Gallinger Municipal Hospital, has been appointed dean, professor, and head of the Department of Medicine at the University of Arkansas School of Medicine, Little Rock.

Visitors to U.S.

J. V. Van Zyl, chief of the Division of Chemical Services, Department of Agriculture, South Africa, and **C. F. J. van der Walt**, an officer of the Division, have arrived in this country and are visiting American research centers. The latter will remain about 9 months, during which time he will acquaint himself with the latest methods in geochemical investigations.

Harold Wergeland, of the Institute for Advanced Studies, Trondheim, Norway, has arrived in the United States to be at Cornell University and later at California Institute of Technology and the University of California. After October 1 Dr. Wergeland will be in residence at Purdue University.

Grants and Awards

Studies on a cancer detection technique will be made by Gregory S. Duboff under a grant recently authorized by the Board of Directors of the Claremore Fund, Los Angeles. In collaboration with Clyde K. Emery, Dr. Duboff will conduct the work in the Emery Tumor Group.

Research on various aspects of alcoholism will be supported by two grants recently announced by the Research Council on Problems of Alcohol. A $30,000 grant, the second installment of a $150,000 project at the New York Hospital-Cornell Medical Center under the direction of Oskar Diethelm, has been made to Cornell University Medical College. In this study, only a few patients are admitted and, while hospitalized at the Payne Whitney Clinic, are given exhaustive physical and psychological examinations. During the first year of the project, certain blood substances, as yet unidentified, were discovered in connection with specific emotional states, increasing with the psychological need for a drinking bout. Attempts are now being made to determine fully the significance of these factors.

The second, in the amount of $20,000, has been made to New York University College of Medicine for a study on biochemical and endocrinological factors in alcoholism. This study will be undertaken in the Department of Medicine, under the direction of James J. Smith.

The Life Insurance Medical Research Fund announces the award of 43 grants in aid of research in the field of cardiovascular disease and 14 postgraduate fellowships for research. The total sum granted for research programs is $484,790. The amount awarded with fellowships is $52,600. Postgraduate fellowship stipends vary from $2,500 to $4,000. These awards bring the total sum made available for aid to medical research by the Fund since its organization in December 1945 to approximately $1,800,000.

Grants in aid of medical research went to:

Bowman Gray School of Medicine for research by Harold D. Green on the peripheral vascular circulation ($8,400).

Carnegie Institution of Washington for research by George W. Corner on the embryological development of the veins of the human brain ($2,000).

The Children's Hospital of Philadelphia for research by T. N. Harris on the cause of rheumatic fever ($15,750).

Columbia University for research by Dickinson W. Richards, Jr., on the action of cardiovascular drugs ($21,000).

Columbia University for research by Rene Wegria on the dynamics of the circulation, especially in the coronary vessels ($7,560).

Duke University for research by Eugene A. Stead, Jr., on the cardiac output and blood flow in various tissues ($31,500).

The Hahnemann Medical College and Hospital for research by John E. Gregory on the influence of heredity on the experimental production of cardiovascular lesions by means of

anaphylactic hypersensitivity ($4,200).

Harvard Medical School for research by Herrman L. Blumgart and Monroe Schlesinger on coronary artery disease ($7,350).

Harvard Medical School for research by Laurence B. Ellis on hemodynamics in patients with heart disease and heart failure ($4,410).

Harvard Medical School for research by Otto Krayer on the metabolic action of the cardiac glucosides and the energy-rich phosphate store of the heart ($7,875).

Harvard Medical School for research by Eugene M. Landis on the earliest stages of heart failure, with special reference to the use of radioactive gases ($18,900).

Harvard Medical School for research by John R. Pappenheimer on the resistance to the peripheral flow of blood ($10,500).

Harvard School of Public Health for research by Frederick J. Stare on the metabolism of heart muscle ($10,500).

The Jewish Hospital, Cincinnati, for research by I. Arthur Mirsky on the role of fibrinolysin in the etiology of rheumatic fever ($5,250).

Johns Hopkins University for research by Elliot V. Newman on changes in renal hemodynamics and electrolyte excretion in heart failure and the influence of treatment ($8,190).

McGill University for research by Hebbel E. Hoff on the afterpotentials of the heart ($3,675).

Michael Reese Hospital, Chicago, for research by Louis N. Katz on experimental arteriosclerosis ($21,000).

The Mount Sinai Hospital, New York, for research by Harry Sobotka on the chemotherapy of hypertension ($5,250).

Mount Zion Hospital, San Francisco, for research by Meyer Friedman on the distribution and fate of digitalis glucosides ($6,825).

The New England Deaconess Hospital, Boston, for research by Elliott P. Joslin on the incidence, nature, and course of degenerative vascular disease in diabetes and an analysis of influencing factors ($10,500).

New York University for research by Norton Nelson on the distribution of readily diffusible materials ($2,100).

Scripps Metabolic Clinic, La Jolla, for research by Eaton M. MacKay on the metabolism of catechol and catechol amines, with reference to their possible role in hypertension ($7,350).

Southwestern Medical College for research by Arthur Grollman on the pathogenesis and treatment of hypertension ($5,565).

Syracuse University for research by Robert F. Pitts and Richard H. Lyons on renal function and circulatory dynamics in cardiovascular disease ($21,000).

Syracuse University for research by Jane Sands Robb on the structure and function of the conducting system of the heart ($8,400).

Syracuse University for research by W. W. Westerfeld and J. M. McKibbin on phospholipid patterns in tissues ($3,675).

Tulane University for research by George E. Burch on the relationship of tropical and subtropical climates to cardiovascular states in health and disease ($39,900).

University of Chicago for research by Konrad Bloch on intermediary cholesterol metabolism ($26,250).

University of Chicago for research by E. M. K. Geiling on the cardiac glucosides ($5,565).

University of Cincinnati for research by Johnson McGuire on cardiac reflexes, myocardial disease, and cardiac function ($7,875).

University of Georgia for research by W. F. Hamilton on the hemodynamics of circulatory disturbances ($16,800).

University of Minnesota for research by Maurice B. Visscher on physical factors in cardiovascular function ($18,900).

University of Oklahoma for research by A. N. Taylor on the nature of the blood flow in the great vessels and its possible relation to arteriosclerosis ($3,465).

University of Pennsylvania for research by H. C. Bazett on the effect of climatic changes on the circulation, with an attempt to develop a respiratory method for estimating cardiac output ($12,600).

University of Pennsylvania for research by Carl F. Schmidt on the cerebral blood flow and oxygen consumption in hypertension; coronary blood flow and cardiac metabolism; and peripheral vascular efficiency ($21,000).

University of Pennsylvania for research by Charles C. Wolferth on fundamental aspects of electrocardiography and blood flow and oxygen tension in skin ($9,345).

University of Southern California for research by H. J. Deuel, Jr., on the role of cholesterol in the development of arteriosclerosis ($15,750).

University of Southern California for research by Clinton H. Thienes on cellular mechanisms in the action of drugs on the cardiovascular system ($21,000).

University of Tennessee for research by Theron S. Hill on the autonomic and central nervous system responses in hypertension ($4,410).

University of Texas for research by George A. Emerson on the cardiovascular effects of carnosine and the metabolism of carnosine in cardiovascular disease ($6,300).

University of Utah for research by Thomas F. Dougherty and Walter S. Loewe on the relation between the adrenal cortex and the function of smooth muscle, particularly of blood vessels ($10,500).

University of Vermont for research by F. W. Dunihue on the source of renal vasopressor substances ($2,730).

Yale University for research by William T. Salter on the chemical control of digitalis therapy ($3,675).

Those awarded postgraduate research fellowships included:

Mogens Faber, M.D., of Copenhagen, Denmark, to work under the supervision of Erwin Chargaff at the Columbia University College of Physicians and Surgeons.

Edward E. Fischel, M.D., of New York City, to work under the supervision of A. R. Dochez at the Columbia University College of Physicians and Surgeons.

Robert E. Forster, II, M.D., of St. Davids, Pennsylvania, to work under the supervision of Eugene M. Landis at the Harvard Medical School.

Claude Fortier, of Montreal, Quebec, to work under the supervision of Hans Selye at the University of Montreal Institute of Experimental Medicine and Surgery.

Noble O. Fowler, Jr., M.D., of Cincinnati, Ohio, to work under the supervision of Johnson McGuire at the Cincinnati General Hospital.

Walter T. Goodale, M.D., of Weston, Massachusetts, to work under the su-

pervision of Eugene C. Eppinger at the Peter Bent Brigham Hospital, Boston.

Theodore H. Greiner, M.D., of St. Louis, Missouri (arrangements for work not yet completed).

John G. Hawley, of New York City, to work under the supervision of Carl J. Wiggers at the Western Reserve University School of Medicine.

Roy G. Herrmann, of Chicago, Illinois, to work under the supervision of E. M. K. Geiling at the University of Chicago Division of Biological Sciences.

Frank J. Kelly, M.D., of Webster Groves, Missouri, to work under the supervision of George E. Burch at the Tulane University School of Medicine.

George E. Murphy, M.D., of Kansas City, Missouri, to work under the supervision of Homer F. Swift at the Hospital of the Rockefeller Institute.

John R. Polley, Ph.D., of Toronto, Ontario, to work under the supervision of J. B. Collip at the University of Western Ontario Faculty of Medicine.

Robert Tarail, M.D., of Minneapolis, Minnesota, to work under the supervision of J. P. Peters at the Yale University School of Medicine.

John Leyden Webb, Ph.D., of Pasadena, California, to work under the supervision of J. H. Burn at Oxford University.

The Division of Research Grants and Fellowships, National Institute of Health, Bethesda, Maryland, announces the following deadlines for receipt of applications for U. S. Public Health Service grants in support of medical research: *June 15* for applications to be reviewed at the September meeting of the National Advisory Cancer Council; *July 15* for applications to be reviewed at the October meeting of the National Advisory Mental Health Council; and *August 1* for applications to be reviewed at the October meeting of the National Advisory Health Council.

The William Bowie Medal, awarded annually by the American Geophysical Union, was received this year by James B. Macelwane, S.J., world-renowned seismologist and director of the Institute of Geophysical Technology, St. Louis University. The award was presented to Dr. Macelwane on the evening of April 21 during the 29th annual meeting of the Union, at the close of the first session of a Symposium on the Earth's Crust, held at the Carnegie Institution of Washington. During the war Dr. Macelwane conducted microseismic studies for the Navy and was largely responsible for establishment of the relationships between microseismic disturbances and storms. He also sponsored the tripartite station method for detecting and tracking hurricanes.

The 1947 Lamme Medal of the American Institute of Electrical Engineers has been awarded to A. M. MacCutcheon, who retired in 1946 as vice-president in charge of engineering, Reliance Electric and Engineering Company, Cleveland, Ohio. This medal, awarded annually since 1928 for high achievements in the development of electric apparatus or machinery, will be presented to Mr. MacCutcheon during the Institute's summer general meeting in Mexico City, June 21–25. He is cited "for his distinguished accomplishments in the development of motors for industrial needs, notably in the steel industry."

Colleges and Universities

The Iowa Lakeside Laboratory on West Okoboji Lake has come under the management of the Iowa State Board of Education and will be governed by a committee representing all three state schools—Iowa State College, Iowa State Teachers College, and the State University of Iowa. Formerly operating under the University of Iowa Summer Session program and the State Conservation Commission, the laboratory has offered research facilities for professors and students in zoology and botany each summer since 1909. J. H. Bodine, head of the University of Iowa Zoology Department, and director of the summer programs at the laboratory since 1934, has been appointed director of the new organization. An advisory committee including faculty members from the three state schools will name other staff members and set up a state-wide program for the unit.

A Department of Egyptology will be established at Brown University as the result of a $750,000 bequest from the late Miss Theodora Wilbour, which carries out the wishes of her father, a newspaperman and lawyer, who was a scholar in Egyptology. Income from the fund will be used by the University to establish the department and endow a chair to be known as the Charles Edwin Wilbour Professorship of Egyptology.

The 31st Mellon Lecture will be given by Eugene F. DuBois, professor of physiology and biophysics at Cornell University Medical College, on May 27 at the University of Pittsburgh. His subject will be: "Why Are Fever Temperatures Over 106° F Rare?" The Mellon Lectures are supported by the heirs of the late R. B. Mellon and are sponsored by the Society for Biological Research of the School of Medicine, University of Pittsburgh.

Natal University College, University of South Africa, has announced the formation of a Department of Physics which will be under the chairmanship of D. Hodges. The College now has a bill before the Union Parliament to raise it to the full status of a university.

The University of Colorado radio program, "Your Career," to be broadcast over 8 Colorado radio stations including KOA, Denver, on May 17 at 10:15 P. M., will feature Lloyd E. Florio, Director of Public Health for the city and county of Denver and professor of public health and laboratory diagnosis at the University's Medical Center, who is well known for his research on rheumatic fever and Colorado tick fever. Dr. Florio will speak on vocational opportunities for young doctors, both specialists and general practitioners. Appearing on the program with him will be Ward Darley, dean of the University of Colorado Medical School, who will discuss the field of medicine and the many phases of medical training.

"Your Career in Medicine" is part of a 13-week series of vocational guidance programs designed to help high school students and graduates evaluate their interests before embarking upon their careers. Biology, chemistry, engineering, geology, and pharmacy have all been discussed on the air by Uni-

versity faculty members and prominent specialists in each of the fields. According to a recent survey, 83% of the Colorado high schools are using these programs for vocational guidance work.

Summer Programs

The Oak Ridge Institute of Nuclear Studies is conducting this summer a series of three one-month courses in the techniques of using radioisotopes. Periods during which these courses will be given are June 28–July 23, August 2–27, and August 30–September 24. According to the announcement, the courses will not attempt to cover any special field of application in chemistry or biology but will be based on simple chemical experiments designed to give participants a maximum knowledge and ability in techniques of handling and conducting research with radioisotopes. Participants in the second of the three courses will be selected by the Atomic Energy Commission; those in the other courses will be chosen from qualified applicants, preference being given to persons affiliated with organizations either now engaging in or planning to engage in research in which radioisotopes are utilized. Thirty-two individuals will be selected for each course. A fee of $25.00 will be charged, and those admitted will be expected to pay their own travel and living expenses while at Oak Ridge. Application forms and further information may be obtained from Ralph T. Overman, acting head of the Institute's Department of Special Training, P. O. Box 117, Oak Ridge, Tennessee.

A Symposium on the Dynamics of Stress and Strain will be offered this summer by the College of Engineering, University of Michigan, through its Department of Engineering Mechanics. Consisting of regular course work and numerous seminars and special lectures, the symposium will treat the following subjects: dynamics of machines and structures, elasticity, plasticity, creep, fatigue, metallurgy of engineering materials, and their engineering applications. Courses on the theory of plasticity will be conducted by John E. Dorn, of the College of Engineering, University of California, and a course in advanced airplane structures, by David J. Perry, Department of Aeronautical Engineering, Pennsylvania State College. Other speakers obtained for this program are J. P. Den Hartog, Massachusetts Institute of Technology; J. Ormondroyd, University of Michigan; N. M. Newmark, University of Illinois; D. B. Steinman, consulting engineer, New York City; C. R. Soderberg, Massachusetts Institute of Technology; and J. Freeman, University of Michigan.

Meetings and Elections

The semi-annual meeting of the Conference on Methods in Philosophy and the Sciences will be held at the New School for Social Research, 66 West 12th Street, New York City, on Sunday, May 9. During the morning there will be a session on "The Keynesian Approach to Business Cycles," during which William S. Vickery, Columbia University, and Michael Kalecki, of UN, will speak. A. P. Lerner, Roosevelt College, and Hans Neisser, New School for Social Research, will lead the discussion. Following a business meeting there will be an afternoon session on "Crucial Problems in Contemporary Physics," the key speakers being P. W. Bridgman, Harvard University, and P. A. M. Dirac, Cambridge University and the Institute for Advanced Study, Princeton. W. Heitler, of the Dublin Institute for Advanced Studies, will lead the discussion.

Scientists from 37 countries will participate in the Fourth International Congresses on Tropical Medicine and Malaria, to be held in Washington, D. C., next week. The program has been organized in 12 sections to cover such subjects as: human diseases which debilitate and kill and those interfering with production and trade; problems of nutrition of man in the tropics; maladies of domestic animals; and most effective uses of new insecticides and drugs. Up to four scientific meetings will be held at one time in meeting halls which have been provided with simultaneous interpretation systems, so that papers will be heard in all of the three official languages, English, French, and Spanish. In addition to the 180 papers scheduled for presentation, there will be daily programs of technical motion pictures, tours to local institutions, and a scientific and commercial exhibition.

The meetings are sponsored by the Department of State in collaboration with other U. S. agencies and scientific societies. This conference will be the first of the International Congresses in this field to be held in 10 years.

The Eastern Association of Electroencephalographers will meet at the U. S. Naval Hospital, National Naval Medical Center, Bethesda, Maryland, on May 15. The program, under the direction of John A. Abbott, of the Massachusetts General Hospital, will include the following papers: Frederick S. Brackett, National Institute of Health, "Some Electrochemical Phenomena at Surfaces"; Leonor Michaelis, Rockefeller Institute for Medical Research, "Fundamentals of Oxidation-Reduction Potentials"; Rafael Lorente de Nó, Rockefeller Institute for Medical Research, "Fields of Action Currents of Traveling Nerve Impulses"; Franklin Offner, Offner Electronics, Inc., and T. W. Winternitz, Chicago, "Potentials Picked Up From an 'Active Dipole' "; Wade H. Marshall, National Institute of Health, "Interaction of Neurones"; Detlev W. Bronk, Eldridge Reeves Johnson Foundation, "The Origin of Rhythmic Potentials in the Nervous System"; David Nachmansohn, College of Physicians and Surgeons, Columbia University, "The Acetylcholine-Cholinesterase System in the Generation of Biopotentials"; and Harold E. Himwich, A. M. Freedman, and P. D. Bales, Army Chemical Center, "Convulsant EEG Patterns Produced by DFP."

The 13th Cold Spring Harbor Symposium on Quantitative Biology will be held June 8–16. The topic is "Biological Applications of Tracer Elements," with emphasis on results obtained rather than on techniques used in experiments. The meeting will be international in scope, with program participants from Denmark (Hans H. Ussing), Great Britain (Ronald Bentley), Sweden (Einar Hammarsten, George Hevesy, and Gösta Ehrensvärd), and Switzerland (K. Bernhard). Attendance will be limited to 80. For program and in-

formation, address the Biological Laboratory, Cold Spring Harbor, New York.

The Viking Fund Physical Anthropology Seminar, at which various aspects of human growth and human evolution will be discussed, will be held June 22 through July 1 at 14 East 71st Street, New York City. W. E. Le Gros Clark, outstanding British anthropologist and chairman of the Department of Human Anatomy, Oxford University, will give a lecture on the evening of July 1 at Hunter College Playhouse. Gabriel Lasker, secretary-treasurer of the Association, states that Dr. Clark will discuss his recent investigations in South Africa, including new specimens of prehistoric Australopithecus which he has studied, as well as the anthropoid fossils found last summer by L. S. B. Leakey in Miocene deposits in East Africa. In addition to Dr. Clark, those invited to attend the Seminar include J. M. Tanner, also of Oxford; William L. Straus, Jr., and Adolph Schultz, of the Johns Hopkins Medical School; Harold Stuart and E. A. Hooton, of Harvard University; Pauline Mack, Pennsylvania State College; J. Lawrence Angel, Jefferson Medical College; W. M. Krogman, University of Pennsylvania; T. Dale Stewart, U. S. National Museum; H. L. Shapiro and Franz Weidenreich, American Museum of Natural History; Dr. Lasker; and others.

Dr. Clark's lecture will be open to all those interested in human evolution. Those interested in participating in the Seminar should write to J. L. Angel, Department of Anatomy, Jefferson Medical College, 307 South 11th Street, Philadelphia.

A conference on mechanical wear will be held in Cambridge, Massachusetts, June 14–16, under the sponsorship of Massachusetts Institute of Technology, the ASME, and the General Motors and Chrysler Corporations. The conference will be devoted to consideration of all aspects of wear between solid surfaces—its causes, symptoms, and cures. In addition to the engineering aspects of the problem, papers will also be presented on the physical and chemical factors in wear. Speakers will include F. P. Bowden, R. Holm, H. Blok, R. H. Savage, R. G. Larsen, and R. W. Dayton. Further particulars may be obtained from J. T. Burwell, Mechanical Engineering Department, Massachusetts Institute of Technology.

The Iowa Academy of Science held a two-day meeting at Fairfield on April 16–17. Cornelius Gouwens, secretary-treasurer, reports that about 350 persons attended and approximately 130 papers were read. In addition to the separate sessions of the 9 sections there was a general session of the Academy, which took the form of a Symposium on Isotopes, and a banquet on Friday evening. The Academy address was delivered by R. A. Moyer, of Iowa State College.

Officers of the Academy for the coming year include: W. H. Kadesch, Cedar Falls, president; J. B. Culbertson, Mt. Vernon, vice-president; F. G. Brooks, Mt. Vernon, editor; and Cornelius Gouwens, Ames, secretary-treasurer.

Invitations to present papers at the First International Poliomyelitis Conference (see *Science*, February 20, p. 187) have been accepted by 20 international authorities in the field, according to Hart E. Van Riper, medical director of the National Foundation for Infantile Paralysis and general chairman of the Conference. The speakers and the plenary session in which they will participate are as follows: The Importance of Poliomyelitis as a World Problem—Albert B. Sabin, University of Cincinnati, and H. J. Seddon, Wingfield-Morris Orthopaedic Hospital, Oxford, England; Poliomyelitis: The Early Stage—Irvine McQuarrie, University of Minnesota, David Bodian, Johns Hopkins University, and Fritz Buchthal, University of Copenhagen; The Management of Poliomyelitis: The Early Stage—John A. Anderson, University of Utah; Poliomyelitis: The Convalescent Stage—E. T. Bell, University of Minnesota, Arthur L. Watkins, Massachusetts General Hospital, and Ralph K. Ghormley, Mayo Clinic; The Management of Poliomyelitis: The Convalescent Stage—William T. Green, Harvard University; The Management of Poliomyelitis: The Late Stage—Joseph S. Barr, Harvard University; Bulbar Poliomyelitis—K. T. Neubuerger, University of Colorado, A. B. Baker, University of Minnesota, and James L. Wilson, University of Michigan; Immunology and Chemotherapy in Poliomyelitis—Isabel M. Morgan, Johns Hopkins University, John R. Paul, Yale University, and Raymond N. Bieter, University of Minnesota; The Public Health Aspects of Epidemic Poliomyelitis—Joseph C. Molner, Deputy Commissioner of Health, Detroit, C. W. Munger, St. Luke's Hospital, and Elizabeth P. Rice, Grace-New Haven Community Hospital.

Following the presentation of papers at each session the speakers will join with a panel of authorities for an open-floor discussion of particular phases of the disease.

The Alabama Academy of Science held its 25th annual meeting at the University of Alabama on April 15–17. Alan T. Wager, secretary, reports that 90 papers were presented at the section meetings. In addition, a joint session of the sections on Biology and Medical Sciences, Industry and Economics, and the Social Sciences was addressed by George W. Snedecor, president of the American Statistical Association. Dr. Snedecor's topic was "Increasing the Efficiency of Sampling Investigations."

Aside from the approximately 300 members and guests who attended the sessions of the Senior Academy, about 150 students were present for sessions of the Junior Academy, held April 16–17. High light of the Junior Academy meeting on the evening of April 16 was the presentation of the Gorgas Scholarships, sponsored by the Senior Academy and the State Chamber of Commerce, to Tommy Scott, Nauvoo (1st); Harry H. Hendon, Birmingham (2nd); James Kassner, Jr., Tuscaloosa (3rd); and Arvilla Ann Kemp, Hueytown (4th). These range in value from $1,200 to $300, respectively, in the order given, in addition to tuition and fees in four cooperating institutions.

Academy officers elected for 1948–49 are: Eugene D. Emigh, Weather Bureau, Montgomery, president; C. A. Basore, Alabama Polytechnic Institute, Auburn, president-elect; A. T. Wager, Birmingham-Southern College, Birmingham, secretary; R. D. Brown, University, treasurer; J. P. Reynolds,

Birmingham-Southern College, councilor to the AAAS; John Xan, Howard College, Birmingham, editor; W. B. Jones, State Geological Survey, Tuscaloosa, and H. B. Rust, Birmingham, Trustees of the Board; and Vera K. Martin, Parrish, counselor for the Junior Academy. Vice-presidents and section chairmen are: Biology and Medical Science, J. H. Walker, University; Chemistry, G. M. Toffel, University; Geology and Anthropology, R. Q. Shotts, University; Geography and Conservation, T. D. Stevens, Alabama Polytechnic Institute, Auburn; Physics and Mathematics, Locke White, Jr., Southern Research Institute, Birmingham; Industry and Economics, T. M. Francis, Birmingham; Science Education, Edith Geisler, Adger; and the Social Sciences, O. L. Lacey, University.

The next annual meeting of the Academy will be held at State Teachers College, Troy, Alabama, during the first weekend in May, 1949, with C. M. Farmer as chairman of the Committee on Local Arrangements.

NRC News

Ten Merck fellowships for the year 1948–49 have been awarded, according to an announcement by the National Research Council. This is the second annual group of fellowships to be granted under a program which is supported by Merck & Co., Inc. The purpose of these awards is to provide advanced training in the related fields of biology and chemistry, particularly for training in one field for persons who already are proficient in another. A gratifying number of applicants was considered, indicating strong interest in this type of fellowship.

Those appointed to fellowships were:

David Henry Brown, Altadena, California, who will work with Carl F. Cori in the Biochemistry Department of the Washington University School of Medicine, St. Louis, on the differences in carbohydrate metabolism in plant and animal tissues.

Daniel Carleton Gajdusek, Yonkers, New York, who will study all phases of protein physical chemistry, in preparation for work in the field of nucleoprotein chemistry as applied to chromosome and virus proteins, with John G. Kirkwood at the California Institute of Technology.

Malcolm Gordon, Austin, Texas, for an investigation of the correlation between enzyme function and morphology as applied to embryonic and cancerous tissues at the California Institute of Technology under G. W. Beadle.

Caspar Wistar Hiatt III, Mentor, Ohio, for advanced study of biophysics, with emphasis on ultracentrifugation and electrophoresis, under the direction of D. A. MacInnes, Rockefeller Institute for Medical Research, New York City.

Rufus Worth Lumry, Jr., Bismarck, North Dakota, who will continue work on the mechanism of enzymic catalysis with Emil Smith at the University of Utah.

Clement Lawrence Markert, Las Animas, Colorado, who will work under Dr. Beadle at the California Institute of Technology on an intensified study of growth, metabolism, and differentiation of cells.

Lorin J. Mullins, Palo Alto, California, whose fellowship was renewed for a second year to enable him to continue work on the general problem of tissue permeability using radioactive tracers. This year he will transfer from the Stazione Zoologica, Naples, Italy, under R. Dohrn, to the Johnson Foundation of the University of Pennsylvania, under D. W. Bronk.

Arthur Beck Pardee of Pasadena, California, whose fellowship was renewed and who is to continue preparation for research in medical chemistry under the sponsorship of Van R. Potter at the McArdle Laboratory for Cancer Research, University of Wisconsin.

Nevin S. Scrimshaw, Rochester, New York, whose fellowship was renewed to further his study of the biological, chemical, and medical phases of abnormalities in pregnancy at the University of Rochester School of Medicine under Karl M. Wilson.

Gunther Siegmund Stent, Urbana, Illinois, who will work at the California Institute of Technology under Max Delbrück on an investigation of the thermodynamics and kinetics of biological reactions.

NRC fellowship boards established to administer the Atomic Energy Commission's research fellowship program in the medical, biological, and physical sciences (*Science*, February 6, p. 136; March 5, p. 241; April 9, p. 367) will receive applications for fellowships in all categories up to June 7 for consideration at the midsummer meetings of the boards.

Deaths

Sumner Cushing Brooks, 59, professor of zoology at the University of California since 1927, died in Bermuda on April 23. He had been conducting studies on permeability at the Bermuda Biological Station while on sabbatical leave from the University.

Edwin W. Hamlin, 42, professor of electrical engineering at Cornell University, died April 24 in Ithaca. Prof. Hamlin joined the Cornell staff last November 1, and early this year became director of Cornell's radio telescope project.

Henry Newell Goddard, 80, professor of biology at Western Michigan College, Kalamazoo, from 1923 until his retirement in 1939, died April 24 at his home in Madison, Wisconsin.

Richard Sisson Austin, 63, since 1921 professor of pathology in the College of Medicine, University of Cincinnati, and director of the Pathologic Service at Cincinnati General Hospital, died April 30 following a month's illness.

Make Plans for—

American Psychiatric Association, May 17–20, Statler Hotel, Washington, D. C.

National Association of Broadcasters, 26th annual convention, May 17–21, and 2nd annual broadcast engineering conference, May 19–22, Biltmore Hotel, Los Angeles, California.

Symposium on Electron and Light Microscopy, sponsored by Armour Research Foundation of Illinois Institute of Technology and Institute's Physics Department, June 10–12, Technology Center, Chicago, Illinois.

III Interamerican Cardiological Congress, June 13–17, Michael Reese Hospital, Chicago, Illinois.

TECHNICAL PAPERS

A Coagulation Defect Produced by Nitrogen Mustard[1]

T. R. SMITH, L. O. JACOBSON, C. L. SPURR, J. G. ALLEN, and M. H. BLOCK[2]

Departments of Medicine and Surgery, The University of Chicago

The observations of Allen, *et al.* (*1, 2*) have indicated that exposure to ionizing radiations, especially in the lethal or semilethal range, produces a prolongation in the whole-blood coagulation time of humans and animals. This effect was found to be due to the appearance of an anticoagulant in the blood biologically indistinguishable from heparin.

Recent observations in our laboratories on 5 human subjects with neoplastic disease and on normal rabbits (*3*) indicate that one of the nitrogen mustards (methyl-bis(β-chloroethyl)amine hydrochloride) produces a coagulation defect identical to that induced by radiations. Previous reports (*4, 5*) dealt with the serious toxic reactions involving the blood and blood-forming tissue of patients with neoplastic disease treated with this agent. A standard course of treatment[3] was found which was relatively safe in the sense that spontaneous recovery always followed in spite of the occasional severe destructive effects on the hemopoietic system. In no instance was the whole-blood clotting time considered to be significantly prolonged.

Of the 5 patients considered in this report, two were given 0.1 mg/kg of body weight on four consecutive days; the third received four injections of 0.1 mg/kg at intervals of 12 hrs; the fourth was given four injections of 0.1 mg/kg at intervals of 7 hrs; and the fifth patient was given only two injections of 0.3 mg/kg, 6 hrs apart. The total dose in each of the 5 cases was 25.4, 26.8, 22.4, 20.0, and 38.0, respectively. Within two weeks after administration of the drug, all 5 patients developed a moderate anemia, severe leucopenia, thrombocytopenia, prolonged bleeding time, cutaneous petechiae, and ecchymoses. The whole-blood coagulation time (Lee White) in each instance was definitely prolonged or was incoagulable in 24 hrs. Gastrointestinal and cerebral hemorrhages were serious complications, and death occurred in two patients. The intravenous administration of toluidine blue or protamine at a dose of approximately 2 mg/kg was usually sufficient to reverse the clotting time to normal for a 24-hr period. The initial or a higher dose of the antiheparin substance was repeated each 24 hrs, as indicated, in an attempt to maintain a normal clotting time. In the test tube also, prolonged whole-blood clotting time could be returned to normal limits by the addition of protamine or toluidine blue. The prothrombin time of all 5 of the individuals was normal.

This report is intended to emphasize the fact that in certain patients nitrogen mustard therapy may produce serious or even fatal complications as the result of the presence of an anticoagulant (heparin ?) in the blood. This hemorrhagic effect can be neutralized *in vivo* and *in vitro* by specific antiheparin substances such as protamine, toluidine blue, and other thionine dyes. This observation is of further interest in drawing attention to the similarities in the biological effects of ionizing radiations and nitrogen mustards.

[1] Supported in part by a grant from the American Cancer Society on recommendation of the Committee on Growth of the National Research Council.

[2] Senior Research Fellow (Cancer), U. S. Public Health Service.

[3] One-tenth mg/kg of body weight given daily for four days.

References

1. ALLEN, J. G., and JACOBSON, L. O. *Science*, 1947, **105**, 388–389.
2. ALLEN, J. G., SANDERSON, M., MILHAM, M., KIRSCHON, A., and JACOBSON, L. O. *J. exp. Med.*, 1948, **87**, 71–86.
3. JACOBSON, L. O., MARKS, E. K., GASTON, E., ALLEN, J. G., and BLOCK, M. H. The effect of nitrogen mustard and other hemopoietic poisons on whole blood coagulation. (To be published.)
4. JACOBSON, L. O., SPURR, C. L., BARRON, E. S. G., SMITH, T. R., LUSHBAUGH, C., and DICK, G. F. *J. A. M. A.*, 1946, **132**, 263–271.
5. SPURR, C. L., JACOBSON, L. O., SMITH, T. R., and BARRON, E. S. G. In *Approaches to tumor chemotherapy.* Washington, D. C.: AAAS, 1947. Pp. 306–318.

Recovery of Pneumoencephalitis (Newcastle) Virus From the Air of Poultry Houses Containing Infected Birds

P. D. DELAY, K. B. DEOME, and R. A. BANKOWSKI

Department of Veterinary Science, University of California, Berkeley

This report describes the recovery of pneumoencephalitis virus from air contaminated as a result of natural infection. The viruses of poliomyelitis (*3*), influenza (*4*), and laryngotracheitis (*1*) have been transmitted by the exposure of susceptible animals to artificially contaminated air. It was assumed, therefore, that these and possibly other virus diseases may be transmitted by the air-borne route under conditions of natural infection, but the presence of virus in such air had not been demonstrated. In the case of pneumoencephalitis, field observations and laboratory experiments indicated the probable transmission of this infection by the air-borne route; hence, these experiments were undertaken to demonstrate

the infectivity of air samples collected from houses containing birds infected with this disease.

The air samples were collected from poultry houses located in an area where pneumoencephalitis vaccination trials had been conducted for several years. Each house contained one pen of nonvaccinated control birds and four pens of birds which had been vaccinated with formalized pneumoencephalitis vaccine. Air samples were taken from the control pens of houses #6 and #9. The control pen in house 6 contained 280 birds which had shown the first clinical evidence of pneumoencephalitis 7 days before the air was sampled; that in house 9 contained 335 birds which had shown the first evidence of infection 10 days prior to the time when the air was sampled. The houses were of shed-roof-type construction containing 5 pens $18' \times 32'$. Each pen had four open windows across the front and two ventilators in the rear. The air in these pens contained a considerable amount of suspended dust, but the dust concentration probably was not different from that usually encountered in poultry houses where deep litter is used.

The air samples were drawn through allantoic fluids harvested from normal 10-day chick embryos by means of the sampling atomizers previously described by DeOme *et al.* (*2*). The air inlets of the atomizers were adjusted to the level of the birds' heads. The volumes of air sampled in houses 6 and 9 were 540 liters and 1,080 liters, respectively. The allantoic fluids from the atomizers were frozen in dry ice immediately after the air was drawn through them, returned to the laboratory, thawed, treated with 10,000 units of penicillin and 24,000 of streptomycin/ml of inoculum, and incubated for 4 hrs at 9° C.

Subsequent culture tests indicated that the treated fluids contained no viable bacteria. Thirteen of fifteen 11-day-old chick embryos injected with 0.2-ml portions of the sample obtained in house 6 died at a mean age of 6.5 days. In two subsequent embryo passages, one-half of generation 2 embryos died at a mean age of 3.6 days, and all of generation 3 embryos died at a mean age of 4 days. The sample from house 9, when inoculated into chick embryos, yielded similar results. The allantoic fluids collected from embryos of generation 3 agglutinated chicken red blood cells, whereas those of generations 1 and 2 failed to do so. Chickens inoculated with the allantoic fluids from embryos of generation 3 developed symptoms of pneumoencephalitis and, upon postmortem examination, presented marked lesions typical of those produced by cultured pneumoencephalitis virus.

These data show that air from an infected house, sampled in 540- or 1,080-liter quantities, contained virus in sufficient concentrations to infect chick embryos.

In an attempt to test the infectivity of such air for chickens, four normal chicks were exposed to the aerial environment of a house containing birds affected with pneumoencephalitis. The four chicks were confined in wire cages suspended $4\frac{1}{2}'$ above the floor. Care was taken to prevent contact with contaminated material which was not air-borne. Respiratory symptoms were observed on the 6th day. On the 8th day the sera from three of the four birds were found to contain hemagglutination-inhibiting antibodies. On the 15th day the birds were returned to the laboratory and challenged with 2×10^5 chicken mid of pneumoencephalitis virus. All four birds were refractive.

No previous report of the isolation of virus from air contaminated as the result of natural infection has been found in the literature.

References

1. DeOme, K. B. *J. inf. Dis.*, in press.
2. DeOme, K. B., *et al.* *Amer. J. Hyg.*, 1944, **40**, 239–250.
3. Faber, H. K., and Silverberg, R. J. *Science*, 1941, **94**, 566–568.
4. Wells, W. F., and Henle, W. *Proc. Soc. exp. Biol. Med.*, 1941, **48**, 298–301.

High-Level Gravels of Western Grand Canyon

Donaldson Koons

Department of Geology, Colby College, Waterville, Maine

Field studies[1] conducted during the summer of 1946 in the vicinity of Western Grand Canyon, Arizona, and the Hualpai Indian Reservation disclosed the presence of large areas of gravel composed of pebbles foreign to the region. Deposits are found at heights of 3,500–4,000′ above present river level. An occurrence of these gravels near Frazier Well, in the Hualpai Reservation, is mentioned by Darton (*1*) without discussion, and two small areas are indicated on the geological map of Arizona (*2*).

Detailed study of the gravel deposits showed that they were more extensive than had been indicated previously and that two types of gravel could be distinguished. The first is composed of poorly rounded and sorted pebbles of limestone, sandstone, and chert of local derivation and rests on steep bed-rock slopes. It is interpreted as a talus and alluvial cone deposit preserved in favorable locations during reduction of the cliffs at the bases of which it was deposited. The name 'Robbers Roost Gravel' is proposed for this group, because of its occurrence in good exposure near the mesa of the same name.

The second gravel, more extensively developed, consists of well-rounded pebbles and boulders of vein quartz, granite, gneiss, schist, red and white quartzite, and sandstone. These gravels are best exposed near Frazier Well and the name 'Frazier Well Gravel' is consequently proposed. The deposits vary in thickness from a thin veneer to more than 200′, the maximum thickness being found near Frazier Well. Present elevation of the deposits varies from 5,660′, 12 miles southwest of Frazier Well to 7,150′, 5 miles northwest of the Well. Though the southern end of the Toroweap Fault passes between these two localities, the total displacement is insufficient to account for the present difference in elevation, and it appears

1 The field work was supported by a grant from the Kemp Memorial Fund of the Columbia University Geology Department.

that part, at least, of this difference is original, resulting from early deposition at the higher elevations, followed by later deposition at the lower elevations. Pebble counts show that at lower elevations granitic and gneissic pebbles comprise up to 50% of the total, while at the highest elevation quartzitic pebbles comprise up to 80% of the total and granitic pebbles are absent. Age of the deposits has not been determined, but weathering to depths of 15′, with partial decomposition of pebbles, has occurred and suggests that the deposits are pre-Pleistocene.

The nearest present outcrop of this assemblage of rock types is 50 miles southeast, in the Basin Ranges northwest of Prescott and Jerome, an area which is today drained by the southeast-flowing Chino Creek. It is suggested that the Frazier Well gravels were deposited by north-flowing streams tributary to the Colorado originating in the Prescott-Jerome area and that drainage reversal followed Basin-Range faulting. If the gravels were deposited during erosion of an uplift to the south, it is to be expected that the older and topographically higher deposits would consist of pebbles derived from the sedimentary cover and that the later deposits would contain a greater proportion of pebbles derived from the underlying crystalline basement. The history of this area may thus be divided into the following stages: first, uplift of the Prescott-Jerome area, accompanied by development of north-flowing tributaries to the Colorado River and deposition of gravels in the Frazier Well area; second, development of Basic-Range faulting; third, reversal of drainage along the margin of the plateau and abandonment of the north-flowing channels.

References

1. Darton, N. H. *Ariz. Bur. Mines Bull. 119,* 1925, 189–190.
2. Darton, N. H., *et al.* Geologic map of the State of Arizona (Arizona Bureau of Mines and U. S. Geological Survey, 1924).

The Path of Carbon in Photosynthesis[1]

M. Calvin and A. A. Benson

Radiation Laboratory and *Department of Chemistry, University of California, Berkeley*

In a previous paper we described the effect of prior illumination on the dark reduction of carbon dioxide by green algae (*Chlorella*) (*4*). The essential experimental factor noted then was a large increase in the amount of carbon dioxide reduced in the dark by the algae which had been just previously illuminated in the absence of any carbon dioxide. Furthermore, some of this reduced radiocarbon was found in positions other than carboxyl groups or the number 3 and 4 carbon atoms of the hexose molecule. This evidence seemed to preclude the possibility that the dark reactions there observed could have been due only to the reversibility of the only two carboxylation reactions yet known to be reversible, namely, the beta carboxylation of pyruvic acid and the beta carboxylation of ketoglutaric acid (*13, 15, 18*). These observations were therefore taken to indicate the ability of the green algae to accumulate a certain amount of reducing power during illumination in the absence of carbon dioxide which could later be used for the reduction of carbon dioxide. The observation by McAlister and Myers (*12*) of a continued uptake of CO_2 after the cessation of illumination in cases of high light intensity and low CO_2 partial pressure might well be the direct manifestation of this situation. In the observations of Hill and Scarisbrick and others (*1, 9, 10, 16*) it was demonstrated that isolated green portions of the cell (chloroplasts and grana) can produce oxygen from water upon illumination in the presence of a suitable oxidizing agent other than carbon dioxide. It now appears clear that the path from carbon dioxide to reduced compounds, such as carbohydrates, fats, proteins, and amino acids, does not include the primary photochemical act itself.

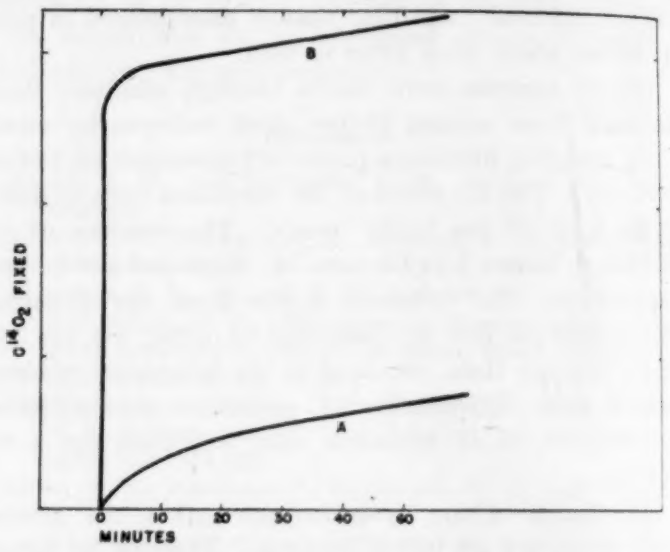


Fig. 1. Dark fixation rate of $C^{14}O_2$ by 2-day-old *Scenedesmus.* Curve A—cells kept in the dark for 1 hr in 4% CO_2–N_2 and then flushed with helium for 20 min; Curve B—same cells as for A following a 10-min exposure to light (2 × 17,000 lux), continuing the rapid flushing with helium. Both curves were obtained by taking aliquots from the main batch of cells and exposing them to $C^{14}O_2$ in the dark for the time period indicated. The concentration of cells in the large vessel was 1 cc of packed cells in 60 cc of nutrient solution, pH 6.2. The volume of the dark fixation vessels and the amount of $C^{14}O_2$ in them was such that the partial pressure of $C^{14}O_2$ was less than 0.2 mm Hg.

The present paper presents a more extensive study of the factors influencing the dark reduction, including another organism (*Scenedesmus*), as well as the beginning of the next stage of this investigation, namely, the products formed during a very short period (30 sec) of photosynthesis. The dark uptake of C^*O_2 by *Chlorella* into nonvolatile products as a function of time was first investigated by Ruben and co-workers (*14*). These authors felt that the amount of carbon dioxide taken up reached a maximum after some 60–80 min of contact. More re-

[1] This paper is based upon work performed under Contract No. W-7405-Eng-48 with the Atomic Energy Commission in connection with the Radiation Laboratory, University of California, Berkeley.

cently, Gaffron, Fager, and Brown (*8*) have shown that this is not the case. By continuing the observations for very long periods, up to 12 or 15 hrs, they showed a continuously increasing amount of dark $C^{14}O_2$ uptake. The present investigation shows (Fig. 1) that this uptake curve actually consists of two distinct portions, the relative importance of which is very sharply dependent upon the prehistory of the algae. The slow terminal rise in both curves might well be due to fermentative fixation analogous to that observed in a variety of animal tissues during respiration (*6, 7*). However, the initial extremely rapid fixation observed in Curve B, Fig. 1 (after preillumination) is quite obviously closely connected with the effect of the light, and its initial slope is approaching that of steady-state photosynthesis. In our view, the initial rapid rise (Curve B) corresponds to the storage by the plant of reducing power generated during the preillumination period. We have examined the rate of generation

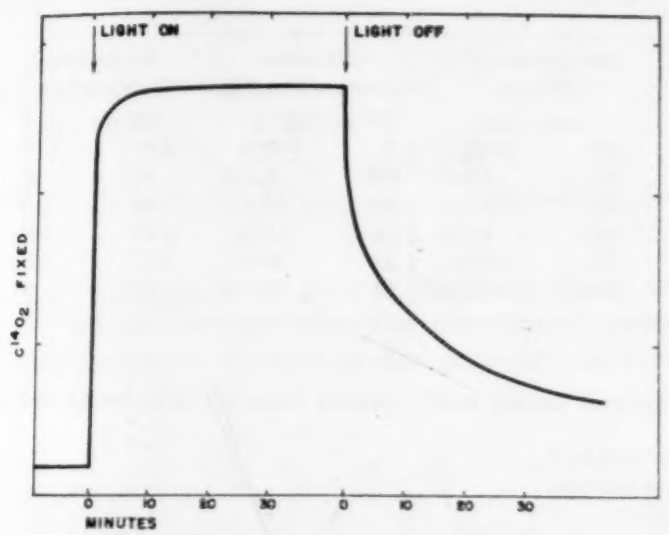


FIG. 2. Effect of preillumination upon 1-min dark fixation (*Scenedesmus*). The abscissa represents the time which the cells spent in the various conditions of light and dark, as indicated, prior to the removal of an aliquot to be tested for dark fixing ability by a 1-min exposure to radioactive CO_2 in the dark. The time interval between the removal of the aliquot from the illumination vessel and its coming into contact with the $C^{14}O_2$ was never more than 3 sec. The ordinate represents the $C^{14}O_2$ fixed by an aliquot of the cells during a 1-min exposure to $C^{14}O_2$ in the dark after the pretreatment shown in the abscissa.

of this reducing power as a function of the preillumination time by observing the amount of $C^{14}O_2$ fixed during a 1-min dark time. The results are shown in Fig. 2. Although, in the particular set of data given in Fig. 2, 30-sec preillumination brings the reducing power to over 80% of its maximum value, we have observed cases in which the full maximum value is reached in the same time. It is clear that this maximum value is simply a steady-state concentration of reducing power resulting from a balance between the rate of its photochemical production and the rate of its natural decay, represented by that portion of the curve in Fig. 2 beyond the point at which the light is turned off. Similar curves showing the growth and decay of reducing power have been obtained with 1-day-old *Chlorella* cultures. However, when older (4-day) cultures of *Chlorella* are used, the apparent rate of growth is somewhat slower, with a correspondingly more rapid rate of decay.

The maximum amount of carbon dioxide fixed is usually 10–15 times that fixed by the cells without preillumination. After complete decay, the reducing power could be repeatedly restored by illumination on the same culture.

Our examination of the compounds into which the radiocarbon is fixed under a variety of conditions has been extended. This includes not only a greater variation in the fixation conditions, but also a more complete identification of the products for each condition. In Table 1 are

TABLE 1

DARK CO_2-FIXATION PRODUCTS OF *Chlorella**
(dark time—5 min)†

	Preillumination‡	None	5 min	60 min	120 min
	Total fixed relative units	1	~10	~10	~10
		(%)	(%)	(%)	(%)
I	Carboxylic acids in either extract§	52	21	14	11
	Malic acid‖	16	11.5	7.4	
	Succinic acid‖	5.2	3.1	0.5	
II	Amino acids¶ adsorbed on cation resin	31	41	64	74
III	Anionic substances** adsorbed on anion resin	16	29	21	
IV	Sugars—nonionized compounds††	0.45	1.0	0.96	1.0

* One-day-old cultures of *Chlorella pyrenoidosa*.

† The cells were killed rapidly by adding 20% by volume of glacial acetic acid-hydrochloric acid (4:1). All radioactive products were in aqueous phase within 5 min. Cells removed by filtration.

‡ One cc of packed cells/60 ml of nutrient solution was illuminated (infrared removed) using 17,000-lux beams from both sides. A rapid stream of helium passed through the suspensions during the experiments. The maximum fixation was not diminished by illumination periods as long as 17 hrs.

§ Rapid, continuous 15-hr extractions.

‖ Separated by partition chromatography on silica gel column.

¶ Eluted from Duolite C–3 resin using 2.5 N hydrochloric acid.

** Eluted from Duolite A–3 resin using 1.5 N sodium hydroxide.

†† Effluate from both exchange resins.

shown the results of an analysis of the products obtained during a 5-min dark fixation time following preillumination periods up to 2 hrs.

Since all of the carbon dioxide fixation induced by preillumination is complete in less than 2 min (see Curve B, Fig. 1), a pair of experiments of the type described in Table 1 was performed in which the dark fixation time was reduced to 1 min. Preillumination times were chosen to insure maximum fixation rates. The results of these experiments are shown in the first two columns of Table 2.

In addition, two very short (30-sec) normal photosynthetic experiments were performed with the two algae. Fractionation proceeded as indicated in Table 1, and the results are shown in the third and fourth columns of Table 2.

Fraction I in both the 1-min dark fixations and the photosynthetic fixations was shown to be 75% malic acid. Fraction II is over 50% alanine in the dark fixations by *Chlorella*. Dark fixation by *Scenedesmus* and photosynthetic fixations by both algae produced not more than 15% alanine in this fraction. Selective elution of the anion exchange resin gave two fractions. The fact that III-A (ammonium hydroxide eluate) was readily rendered resistant to ammonia elution by cold evaporation of the eluate in the presence of air suggested that this radioactive product was a reduced form of that obtained in III-B (sodium hydroxide eluate). The radioactive substance in fraction III-B of the 10-min preilluminated *Scenedesmus* was identified as phosphoglyceric acid. Hydrolysis by boiling 1 N hydrochloric acid gave radioactive glyceric acid which was adsorbed on the anion exchange resin and eluted with ammonium hydroxide. The glyceric acid was identified by preparing *p*-bromophenacylglycerate which was crystallized to constant specific activity. Solvent distribution of the derivative as well as the free acid gave distribution coefficients identical with those of authentic specimens. The radioactive substances in fraction III-B, formed during the 30-sec photosynthesis in *Scenedesmus*, were likewise shown to be more than 80% phosphoglyceric acid. Fraction III-A, after air oxidation in ammonia, was found to contain over 90% phosphoglyceric acid and approximately 4% sugar phosphate. It thus appeared that the major original component of fraction III-A which gave rise to the phosphoglyceric acid was triose phosphate. A subsequent experiment with *Scenedesmus* (photosynthesizing for 30 sec) demonstrated that such is actually the case.[2] This was qualitatively confirmed by the isolation of radioactive pyruvaldehyde-2-4-dinitrophenylosazone (*3*) from the steam distillate following hot acid hydrolysis of the original extracts. Pyruvaldehyde was not present prior to the hydrolysis. In separate experiments, fraction IV has been shown to be glucose and fructose in almost equal amounts.

In addition to the above-described identification work, a certain amount of degradation has been performed on several of the identified compounds. Perhaps the most illuminating of these results is the distribution of C^{14} found in the hexose fraction for a number of different preparations (*2*). In the glucose obtained from the dark fixation in preilluminated *Chlorella* and from the 30-sec photosynthesis of *Scenedesmus*, from 75 to 90% of the radioactive carbon was contained in the 3 and 4 positions, the remainder being found in the 1,2 and 5,6 positions. In glucose obtained from barley shoots which had been photosynthesizing for 1 hr in $C^{14}O_2$, the distribution was 61% in the 3,4 position, 24% in the 2,5 position, and 15% in the 1,6. In glucose obtained from barley which had been photosynthesizing for 2 hrs, the distribution was 37% in 3,4, 36% in 2,5, and 27% in 1,6. In view of the presence of such large amounts of radioactive triose phosphate and phosphoglyceric acid in the very short photosynthetic experiments (30 sec) as well as in the dark fixation, it can be taken as fairly certain that the hexose synthesis proceeds by a reversal of the usual glycolytic split of fructose diphosphate, and therefore some path must be found by which the radioactivity appears first in the number 1 carbon atoms of the 3 carbon compounds and gradually spreads into the number 2 and then the number 3 carbon atom of the triose phosphate and the phosphoglyceric acid. A similar variation of the distribution of radiocarbon in alanine, spreading from the number 1 carbon atom into the other two, has also been found. It is reasonable to suppose that the alanine distribution is an index of the distribution in pyruvic acid, and the problem therefore becomes that of determining the path from carbon dioxide to pyruvic acid which would give this characteristic distribution. So far we have been able to account for the major fraction of the radioactive carboxylic acids formed in terms of only the 4 carbon acids. If there is any aconitic or ketoglutaric acid at all, it is small in amount. We are therefore led to the supposition that the 3 carbon compounds are produced through

TABLE 2

DISTRIBUTION OF C^{14} IN ALGAE

Alga		*Chlorella**		*Scenedesmus*†		*Chlorella*		*Scenedesmus*	
Preillumination time		60 min		10 min		Photosynthesizing		Photosynthesizing	
Fixation time		1 min dark		1 min dark		30 sec light‡		30 sec light‡	
Total C^{14} fixed (c.p.m. $\times 10^{-6}$)		.96	100%	.97	100%	3.1	100%	6.2	100%
I	Ether extractable acids	.13	13%	.12	12%	.078	2.5%	.64	10%
II	Cationic (amino acids)	.51	53%	.38	39%	.44	14%	.68	11%
III-A	Anionic. Ammonia elutable§	.023	2.4%	.041	4.2%	1.19	38%	2.75	44%
III-B	Anionic. Not ammonia elutable‖	.30	31%	.41	42%	1.13	36%	1.67	27%
IV	Neutral substances (sugars)	.0033	0.3%	.0013	0.1%	.14	4.5%	.29	4.7%

* *Chlorella pyrenoidosa*, 1-day-old cultures.

† *Scenedesmus* D–3, 2-day-old cultures.

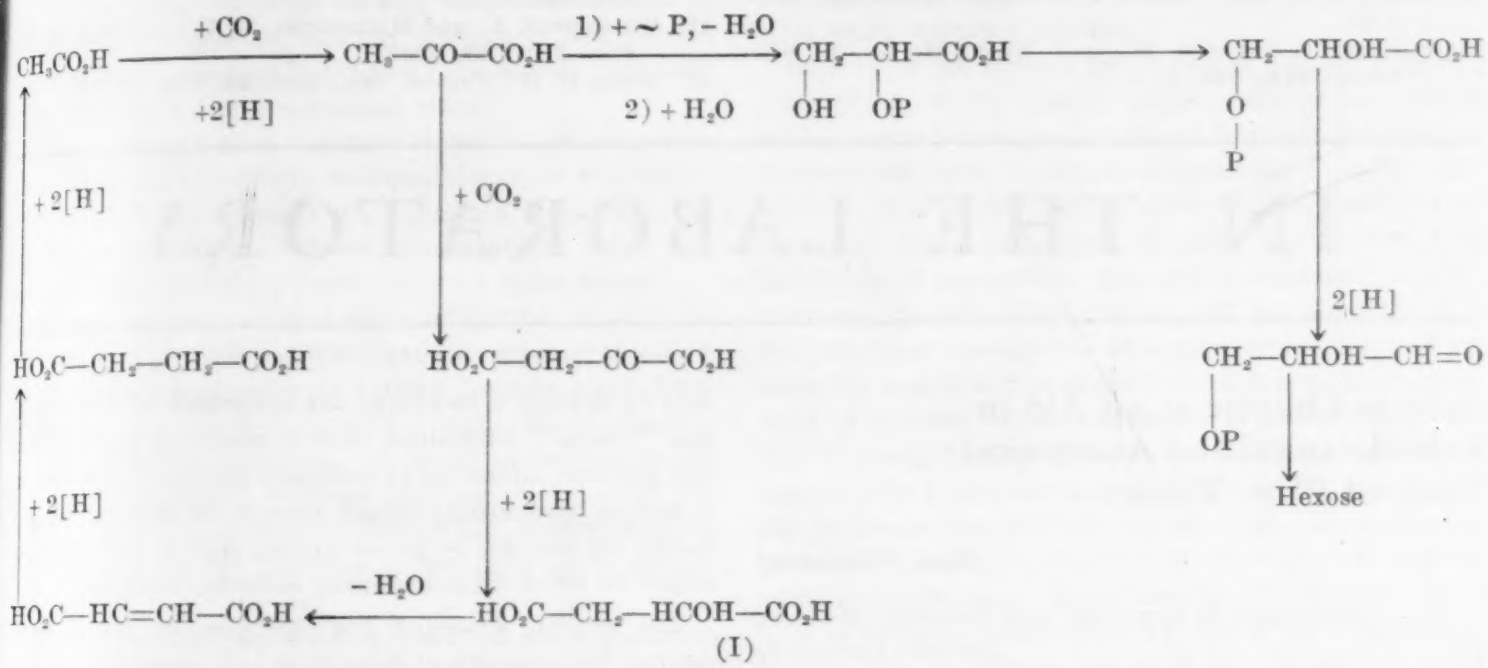
‡ Cells rapidly photosynthesizing were given radioactive carbonate and shaken until removed from the light beams and instantly killed.

§ Adsorbed on Duolite A–3 and eluted with 1.5 N ammonium hydroxide.

‖ Eluted with sodium hydroxide following the previous ammonia elution.

[2] Unequivocal identification must await carrier experiments with authentic triose phosphates.

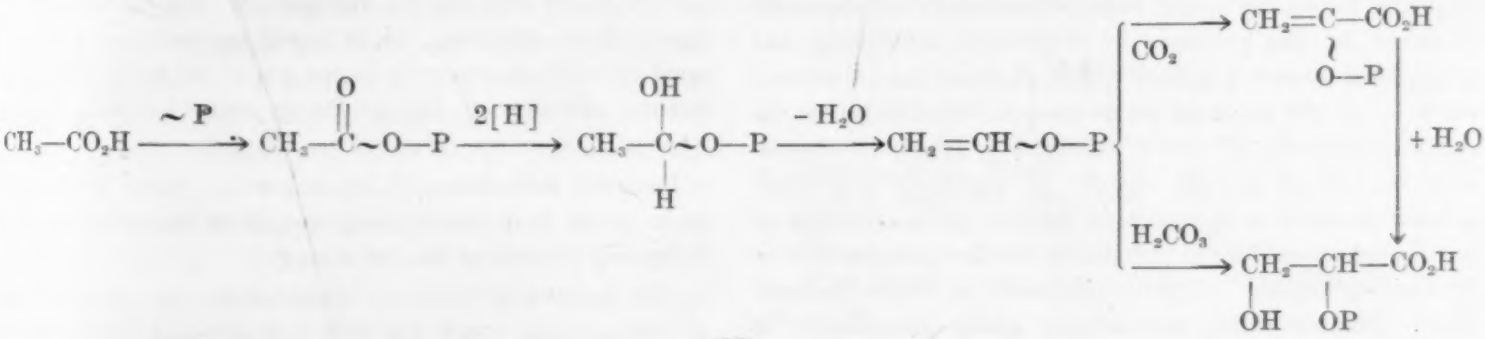
the 4 carbon dicarboxylic acids. Furthermore, the acceptors for the one or more carboxylation reactions which take place must be regenerated not only continuously but in such a manner as to contain a gradually increasing amount of isotopic carbon, relatively rapidly approaching the isotopic concentration of the carbon dioxide itself. All this can be achieved, with currently used reactions,



(I)

only by the presence of what is effectively $C_3—C_1$ addition. We are therefore led to the reiteration of a scheme already proposed to describe the path of the carbon atoms (see I, above).

The precise nature of the reducing agent or agents cannot yet be stated, nor can we say which of the reducing equivalents required by the operation of the cycle had their origin in the photosynthetic reaction. The proposed



(II)

It should be realized that these are all enzymatic reactions and the precise form of the reaction species is not specified. For example, the reductive carboxylation of acetate through pyruvate to phosphoglyceric acid could conceivably proceed by the steps shown in II.

With this as a working hypothesis, specific tests are already under way. Thus, when carboxyl-labeled acetate is fed to preilluminated *Chlorella* for a 5-min period in the dark, the isolated alanine contains about 35% of its radioactivity not in the carboxyl group. The presence of C^{14} in the carboxyl group of the alanine could be due to the oxidative metabolism of some of the acetate through the tricarboxylic cycle in the manner already familiar in animal tissues and yeasts (*5, 11, 17*) or by the direct oxidative coupling of two acetates to succinate. Also, the succinic acid isolated from preilluminated *Chlorella* after dark fixation of $C^{14}O_2$ showed 2.5% of the radioactivity in the methylene groups, while the succinic acid from the aforementioned 2-hr photosynthesizing barley experiment had 37% in the methylene groups.[3, 4]

The amount of radioactivity found in any compound or carbon atom in a specific compound will depend upon the size of its actively functioning reservoir and the relative rates of all the reactions leading to and from that reservoir under any specific set of experimental conditions.

scheme for the path of carbon in photosynthesis still remains as the most likely one in view of the presently available experimental facts.

References

1. Aronoff, S. *Plant Physiol.*, 1946, **21**, 393.
2. Aronoff, S., Barker, H. A., and Calvin, M. *J. biol. Chem.*, 1947, **169**, 459.
3. Baer, E., and Fischer, H. O. L. *J. biol. Chem.*, 1943, **150**, 223.
4. Benson, A. A., and Calvin, M. *Science*, 1947, **105**, 648.

[3] The method of succinic acid degradation is that of Benson, Bassham, and Calvin, to be published.

[4] The analysis of algae given in column I of Table 1 (see 4) corresponds to fixation under the conditions represented by a 30-min point on Curve A, Fig. 1, of the present note. It is entirely possible that the succinic acid found therein, which was entirely carboxyl labeled, may have been formed in large part by reversibility of the Wood-Werkman reaction.

5. Bloch, K. *Phys. Rev.*, 1947, **27**, 574.
6. Buchanan, J. M., and Hastings, A. Baird. *Physiol. Rev.*, 1946, **26**, 120.
7. Evans, E. A., Jr. *A symposium on respiratory enzymes.* Madison: Univ. of Wisconsin Press, 1942. P. 197.
8. Gaffron, H., Fager, E. W., and Brown, A. Reported at Isotope Symposium, Univ. Wisconsin, 1947.
9. Hill, R., and Scarisbrick, R. *Nature, Lond.*, 1940, **146**, 61.
10. Holt, A. S., and French, C. S. *Arch. Biochem.*, 1946, **9**, 25.
11. Lorber, V., Lifson, N., and Wood, H. G. *J. biol. Chem.*, 1945, **161**, 411.
12. McAlister, E. D., and Myers, J. *Smithsonian Instn Publ.* (Misc. Coll.), 1940, **99**, No. 6.
13. Ochoa, S., Mehler, A., and Kornberg, A. *J. biol. Chem.*, 1947, **167**, 871.
14. Ruben, S., Kamen, M. D., and Hassid, W. Z. *J. Amer. chem Soc.*, 1940, **62**, 3443.
15. Vennesland, B., Ceithmal, J., and Gollub, M. C. *J. biol. Chem.*, 1947, **171**, 445.
16. Warburg, O., Lüttgens, W. *Naturwiss.*, 1944, **32**, 161, 301.
17. Weinhouse, S., and Millington, R. H. *J. Amer. chem. Soc.*, 1947, **69**, 3089.
18. Wood, H. G. *Physiol. Rev.*, 1946, **26**, 198.

IN THE LABORATORY

Sodium Chlorite as an Aid in Paleobotanical and Anatomical Study of Plant Tissues

E. S. Barghoorn

Biological Laboratories and *Botanical Museum, Harvard University*

In the study of plant tissues, both living and fossil, it is frequently desirable to prepare bleached and cleared whole mounts of various plant parts. The identification of leaf and root fragments as well as other plant remains in peats, brown coals, and organic sediments is frequently hindered by the presence of "humic" substances and amorphous brown residues which obscure the structural residues of the original plant tissues. Similarly, in the anatomical study of living plants it is frequently necessary to extract a wide variety of pigments and other colored substances in order to clarify cellular details of floral organs, epidermal structures, or the vascular tissues of various organs or parts prepared as whole mounts. Plant remains which occasionally occur abundantly in archeological sites are often very fragmentary and friable, a condition which renders them difficult to study by the ordinary histological methods of embedding and sectioning. Such plant remains, however, commonly possess distinctive anatomical features of value in identification when the delicate tissues are carefully bleached and cleared.

Partial decolorizing and clearing of plant parts, both living and fossil, is often accomplished by the use of dilute aqueous NaOH or KOH. Fossil plant fragments and delicate tissues of living plants, however, frequently become excessively soft and almost gelatinous after caustic treatment, making it extremely difficult, if not impossible, to prepare satisfactory slides for study and reference. This is particularly true of fossil plant tissues, which not uncommonly dissolve after prolonged exposure to caustic.

In recent studies of the macroscopic plant remains in postglacial peats and tertiary lignites it was found necessary to develop a technique for extraction of the lignin and "humic" substances with a minimum of chemical and physical alteration of cellulosic residues. By such a technique structurally intact tissues as well as microfossils represented by pollen grains, spores, and diatoms might be freed from obscuring colloidal residues.

The method developed for this purpose has proven entirely satisfactory. Subsequent experimentation has shown it to be adaptable for many other purposes in the study of plant tissues where there is need for strong bleaching with little loss of strength or tendency for maceration. The procedure is essentially a modification of the Cross and Bevan method for the extraction of lignin from cellulose. It is based on techniques developed in cellulose research in the paper industry, utilizing sodium chlorite as the oxidizing and bleaching agent (*1–5*).

For the extraction of heterogenous plant fragments from peats and incompletely coalified brown coals the following procedure has been useful:

(1) Swell and partially deflocculate the material in 5–10% aqueous KOH for 6–24 hrs at room temperature. The action, if too drastic, can be curtailed by the use of 50% alcohol instead of water. After treatment, the softened mass may be carefully broken apart to accelerate subsequent treatments. Brown clays rich in organic matter often deflocculate completely after boiling in 10% sodium carbonate.

(2) Wash with water by successively decanting to remove excess caustic and soluble humic substances. If microfossils are to be recovered, a portion of the mixture may be washed and centrifuged after alkali deflocculation and the pollen grains and spores removed for acetolysis or other treatment. At this stage, larger plant fragments such as roots, rhizomes, and small seeds may be removed.

(3) Flood the residues with lactic acid (85%) or dilute mineral acid sufficient to neutralize the remaining alkali. With acidification the color of the plant tissues becomes much lighter, and the solution clarifies somewhat.

At this stage the peat or lignite residues may be examined in a binocular microscope and the discrete fragments removed.

(4) Decant the excess acid and add an excess of 2–5% aqueous solution of sodium chlorite. If the mixture is sufficiently acid, the prompt evolution of chlorine dioxide takes place. The degree of acidity determines the speed of the reaction. Chlorine dioxide resembles chlorine in its corrosive properties, and the reaction is best carried out in a hood, although a covered (not sealed) container may be used in a well-ventilated room.

The bleaching action may take several hours. If necessary, the acidified chlorite solution should be renewed.

(5) After chlorination the bleached cellulosic and cuticular residues are washed thoroughly in water and mounted in glycerin, glycerin jelly, or other media.

This procedure, which may be employed on any unconsolidated organic sediment, can be variously modified. The primary purpose is to extract discrete plant fragments and to bleach them with a minimum of chemical or mechanical degradation. If the plant fragments can be removed without swelling and deflocculation of the matrix, steps 1 to 3 may be eliminated. Pretreatment is not essential for the bleaching action, although it accelerates it.

The sodium chlorite method was tried after numerous modifications of the Cross and Bevan procedure had been tested. With other methods little success was encountered in the recovery of delicate structural residues such as the epidermal layers of roots, leaf cuticles, and other structures which tend to fragment, "clump," or even completely dissolve during successive washings, centrifuging, and other drastic manipulation. The great advantage of the chlorite procedure is that virtually complete delignification and "dehumification" can be accomplished in one solution and at an easily controlled rate. The speed of the action may be varied with the concentration and acidity of the chlorite solution. Similar results are obtainable by the use of sodium hypochlorite solutions (commercial bleaches). These, however, are unsatisfactory because of more intense oxidative action resulting frequently in the dissolution of delicate cellulosic residues.

Sodium chlorite is a salt of somewhat unstable composition. Under ordinary laboratory conditions it is perfectly safe to handle without special precautions. High temperatures and intimate contact with easily oxidizable substances such as sulfur and rubber, however, can lead to rapid decomposition or explosion, and some care is necessary in using the reagent. In aqueous solution sodium chlorite slowly decomposes, particularly in the presence of light.

Sodium chlorite has an oxidation potential between hypochlorite and hydrogen peroxide, even when used in fairly acid solutions (*3*). Chlorite oxidation is sufficiently slow, therefore, that presumably no oxidative degradation of plant cellulose takes place except after prolonged exposure. This is apparently true of its behavior not only with normal plant tissues but also on the degraded cellulosic residues of fossil plants.

Extensive use of sodium chlorite solutions in the preparation of fossil plant fragments for anatomical study indicates that the resulting residues are essentially the remaining "holocellulose" fractions of the fossil plant tissues. Determination of the cuprammonium fluidity of such residues indicates that the fossil plant "holocellulose" fractions are composed largely of highly degraded cellulose which differs both chemically and physically from unaltered plant cellulose.

Because of its unusual properties of delignifying and dehumifying woody tissues, sodium chlorite has proven useful in the histological study of cell-wall degradation in peats and other fossil plant deposits. A major difficulty in such studies results from the accumulation of obscuring lignin and humic residues, which often take the form of amorphous granules simulating bacterial colonies. Careful delignification and bleaching by chlorite solutions removes the obscuring substances and reveals the unmodified or partially modified cellulosic fractions of the wall. In recent studies of cell-wall degradation in woods from peat deposits it has been possible to demonstrate a selective retention of various lamellae of the cellulosic fractions of the cell wall. These studies have been greatly facilitated by staining thin sections after delignification. Experience has shown that stains such as ruthenium red, safranine, and Hiedenhains hematoxylon are selectively absorbed by chlorinated plant tissues in a manner similar to that in untreated plant tissues, although the intensity of the stain is less.

After prolonged treatment with dilute chlorite there is no detectable reduction in the intense optical activity of cellulose in polarized light.

References

1. Jayme, G. *Cellulosechem.*, 1942, **20**, 43–49.
2. Lovell, E. L. *Ind. eng. Chem.*, 1945, **37**, 1034–1037.
3. Taylor, M. C., White, J. F., and Vincent, G. P. *Tech. Ass. pulp pap. Ind.*, 1940, **23**, 251–256.
4. Taylor, M. C., White, J. F., and Cunningham, R. *Ind. eng. Chem.*, 1940, **32**, 899.
5. Wise, L. E., *et al.* *Pap. Trade J.*, 1946, **122**, No. 2, 35–43.

Paper Chromatography Using Capillary Ascent[1]

Roger J. Williams and Helen Kirby

Biochemical Institute, University of Texas, The Clayton Foundation for Research, and *Department of Chemistry, University of Texas*

Chromatography, which has most often involved the use of a column of finely divided adsorbent (e.g. alumina) through which solutions and solvents are allowed to percolate, has proved an invaluable tool in separating and analyzing constituents of mixtures. Consden, Gordon, and Martin (*1*) have successfully developed the use of strips or sheets of filter paper as the "column" by dipping the upper edge in a reservoir of an organic solvent saturated

[1] This research was supported in part by a grant from the Research Council on Problems of Alcohol.

with water and allowing the liquid to flow down over the paper. This method has found wide and important applications for both qualitative and quantitative work (*2–10*).

In the present study we have applied the general idea of Consden, *et al.* in a preliminary way to the analysis of amino acid mixtures and have found that allowing the solvents to *ascend* by capillary action, rather than to descend, as has been common in all types of chromatography, has tremendous advantages with respect to consistency of results, simplicity of apparatus, and particularly the ease with which large numbers of analyses can be made. By introducing other modifications we have approximately doubled the sensitivity of the method for amino acids.

The apparatus which we have developed for the purpose of analysis on a relatively large scale is extremely simple, consisting of a series of 6-gal earthenware jars, in the bottoms of which are placed 10″ Pyrex pie plates, each containing about 100 ml of a suitable solvent mixture. The jar is fitted with a cover in the form of a square of plate glass. By grinding the upper edge of the jar to a plane surface and sanding the glass cover at the area of contact, the seal can be made airtight by the use of desiccator grease. Airtightness is not always essential.

In its simplest operation the filter paper (Whatman No. 1) to be used is in the form of sheets 18″ × 11¼″, obtained by cutting the larger sheets as purchased in two, using a power-driven paper cutter. Along one long edge of the paper, about 1″ from the margin, are placed, at intervals of about ¾″, solutions of the samples to be analyzed, and after drying, the sheet is formed into a cylinder about 6″ in diameter. The edges are stapled together with wire staples so that they do not quite touch.

In operation the paper cylinder is allowed to stand upright, with the dried spots comprising the samples near the bottom, in the Pyrex dish containing the solvent mixture. The whole vessel is covered with the plate glass and allowed to stand until the solvent front has nearly reached the top of the paper cylinder. This requires 12–18 hrs, depending on the solvent used. We have not yet been concerned with analyses in which close temperature control was desirable. Obviously, this simple apparatus would lend itself to such control more readily than more complicated arrangements.

For practical purposes various modifications of this setup are valuable. For example, in exploratory work we have found it desirable to carry out adsorptions in 1,000-ml cylinders or in plain glass cylinders of similar dimensions. In this case, the solvent mixture is merely placed in the bottom and a paper cylinder of suitable size is used. Several samples can be run simultaneously in this manner.

In case the output of the apparatus needs to be expanded beyond what is possible using a single paper cylinder in the 6-gal jar, concentric cylinders, e.g. 7″, 6″, and 5″ in diameter, can be used simultaneously. By this means a series of 6 jars fitted in the manner described can be used for the production of about 450 individual one-dimensional chromatograms per day. The parallel production of a large number of chromatograms under substantially identical conditions is particularly valuable in quantitative estimations involving matching of the size and intensity of color of the spots obtained (as in amino acid analyses), because several dilutions of the unknown sample and of the standard solutions are thus made available for direct comparison.

TABLE 1

	Consden, et al. (descending) (various addenda)	*Dent* (descending) (NH_3 added)	*W and K* (descending) (28 hrs, 38 cm)	*W and K* (ascending) (28 hrs, 28 cm)
Glycine	.40–.42	.42	.37	.36
Alanine	.54–.59	.62	.58	.55
Norvaline	.78–.81	..	.78	.75
Valine	.76–.78	.80	.75	.72
Norleucine	.85–.89	..	.80	.83
Leucine	.83–.88	.85	.84	.80
Isoleucine	.81–.86	..	.82	.83
Serine	.33–.36	.35	.33	.30
Threonine	.41–.50	.50	.45	.43
Cystine	.13–.30	.21	.24	.24
Methionine	.76–.83	.82	.74	.74
Proline	.85–.91	.86	..	.88
Aspartic acid	.12–.17	.17	.25	.22
Glutamic acid	.13–.28	.28	.27	.23
Phenylalanine	.86–.90	.86	..	.83
Tyrosine	.59–.64	.63	..	.55
Tryptophane	.76–.86	.77	.74	.71
Histidine	.68–.72	.77	..	.62
Arginine	.59–.89	.87	.48	.54
Lysine	.46–.82	.80	.48	.41

The same apparatus is readily adapted to the production of two-dimensional chromatograms which can conveniently be run two at a time. In this case, a single sample is placed about 1″ from the lower corner of a sheet 11″ square. After drying, two such sheets are formed into a cylinder by clipping them along two edges and allowed to stand with the lower edge immersed in the solvent mixture as before. After the solvent front has risen nearly to the top, the cylinder is removed and dried, unfastened, and reformed into a new cylinder in which the samples are distributed along the bottom. After the regular period, the two-dimensional chromatogram is ready for further processing and evaluation.

The general precautions used in this type of manipulation are similar to those described by other workers, and the procedures used in drying and processing the paper for amino acid determinations are essentially the same. The use of paper cylinders which can stand unsupported is of great convenience in connection with drying and handling. By the use, for example, of phenol which has been purified by vacuum distillation over zinc dust in an all-glass apparatus, we have been able to obviate the undesirable and extraneous color streaks which otherwise develop (*1*). Moreover, using saturated salt solution instead of water to mix with the phenol (or other solvent) prevents "water logging" (*1*) and inhibits the production of a brown front (*1*), presumably due to copper in the filter paper, which in amino acid analyses accompanies

glycine. We have found in the case of amino acid analyses that by using a 0.25% ninhydrin solution in saturated butanol-water, we can obtain about the same intensities of color from 2 γ amounts of the amino acids as can be obtained from 4 γ amounts using the usual 0.1% solution.

ing'' and ''ascending'' chromatograms made under parallel conditions by us have been compared, and the ''ascending'' chromatograms are in general definitely superior.

Table 2 gives R_F values for the various amino acids when different solvents are used as determined by Cons-

TABLE 2*

	Collidine		Benzyl alcohol		1–1 v/v benzyl alcohol butanol		Butyl alcohol		Isobutyric acid	
	Consden, et al.	*W and K*	*Consden, et al.*	*W and K*	*Consden, et al.*	*W and K*	*Consden, et al.* (3% NH_3)	*W and K*	*Consden, et al.*	*W and K*
Glycine	0.25	0.26	0.02	0.02	0.03	0.02	0.05	0.03	0.36	0.34
Alanine	0.32	0.32	0.03	0.05	0.05	0.04	0.09	0.06	0.44	0.42
Norvaline	0.48	0.44	0.12	0.14	0.19	0.15	0.31	0.25	0.71	0.68
Valine	0.45	0.43	0.11	0.14	0.15	0.15	0.22	0.21	0.65	0.63
Norleucine	0.60	0.55	0.27	0.21	0.36	0.26	0.51	0.41	0.79	0.79
Leucine	0.58	0.55	0.21	0.21	0.31	0.25	0.46	0.35	0.78	0.77
Isoleucine	0.54	0.53	0.18	0.20	0.27	0.23	0.40	0.34	0.76	0.74
Serine	0.28	0.30	0.01	0.01	0.02	0.02	0.05	0.04	0.34	0.32
Threonine	0.32	0.32	0.02	0.02	0.04	0.02	0.08	0.05	0.43	0.41
Cystine	0.14	0.11	0.00	0.00	0.00	0.01	0.01	0.01	0.25	0.14
Methionine	0.57	0.53	0.17	0.14	0.21	0.15	0.05	0.22	0.69	0.63
Proline	0.35	0.34	0.12	0.15	0.12	0.11	0.14	0.08	0.57	0.55
Aspartic acid	0.22	0.23	0.00	0.00	0.00	0.01	0.01	0.01	0.31	0.27
Glutamic acid	0.25	0.27	0.00	0.00	0.07	0.00	0.01	0.02	0.38	0.33
Tyrosine	0.64	0.59	0.14	0.07	0.19	0.11	0.14	0.14	0.58	0.47
Tryptophane	0.62	0.59	...	0.15	0.30	0.20	...	0.20	...	0.63
Histidine	0.28	0.30	0.02	0.01	0.03	0.02	0.09	0.02	0.45	0.36*
Arginine	0.16	0.17	0.01	0.01	0.01	0.01	0.05	0.03	0.40	0.38*
Lysine	0.14	0.11	0.00	0.01	0.01	0.01	0.03	0.01	0.27	0.34*

* When chromatographed in an acid solvent, these basic amino acids yield diffuse bands. The values given represent the maxima.

Values obtained by Consden, *et al.* are from *descending* chromatograms. Those under "W and K" are *ascending* values.

Table 1 gives R_F values for various amino acids as determined by Consden, *et al.* and by Dent, using the descending procedure, and by ourselves using both descending and ascending methods. All of these values apply to the use of phenol-water as the solvent. In the work of Consden, *et al.* and Dent, various agents, NH_3, HCN, Cupron, were added to the system to avoid the production of extraneous colors. We have used only purified phenol.

It may be noted that the ascending values do not differ very significantly from the descending values, though they are frequently a little lower. We have found, in the ''ascending'' procedure using the paper cylinder, that the solvent front is likely to be far more even than when a sheet is used employing the descending method. The use of the paper cylinder makes it possible to introduce the entire edge of the paper into the solvent mixture at one time, and the paper extends straight upward, avoiding the bend necessary in the descending method. Furthermore, the paper throughout its length maintains a vertical position without any tendency to wrinkle or roll. These factors are doubtless responsible for a more even solvent front and, in addition, cause the separations to be more clear cut. A considerable number of ''descend-

den, *et al.* (*1*) and in the present study using the ascending procedure.

Our experience in applying this method to the quantitative determination of minute amounts of amino acids is as yet limited, but from the experience of others, as well as our own, it appears that, especially with the simplification and refinement in procedure here described, paper chromatography will be found to be an increasingly important research tool in analyzing for amino acids and numerous other substances.

References

1. Consden, R., Gordon, A. H., and Martin, A. J. P. *Biochem. J.*, 1944, **38**, 224.
2. Consden, R., Gordon, A. H., and Martin, A. J. P. *Biochem. J.*, 1947, **41**, 590.
3. Dent, C. E. *Biochem. J.*, 1947, **41**, 240.
4. Dent, C. E. *Nature, Lond.*, 1947, **160**, 801.
5. Flood, A. E., Hirst, E. L., and Jones, J. K. N. *Nature, Lond.*, 1947, **160**, 86.
6. Lugg, J. W. H., and Overell, B. T. *Nature, Lond.*, 1947, **180**, 87.
7. Maw, G. A. *Nature, Lond.*, 1947, **160**, 261.
8. Partridge, S. M. *Nature, Lond.*, 1946, **158**, 270.
9. Phillips, D. M. P. *Nature, Lond.*, 1948, **161**, 53.
10. Polson, A., Mosley, V. M., and Wyckoff, R. W. G. *Science*, 1947, **105**, 603.

Scientific Book Register

BROCH, HJALMAR. *Stylasteridae (hydrocorals) of the John Murray Expedition to the Indian Ocean.* (John Murray Expedition, 1933–34, Sci. Reps., Vol. VIII, No. 2.) London: British Museum (Natural History), 1947. Pp. 305–316. (Illustrated.) 2/6d.

COWDRY, E. V. *Laboratory technique in biology and medicine.* (2nd ed.) Baltimore: Williams & Wilkins, 1948. Pp. vi + 269. $4.00.

CRIEGEE, R., *et al. Newer methods of preparative organic chemistry.* (Translated and revised from the German.) New York: Interscience, 1948. Pp. xiii + 657. $8.50.

DE MEILLON, BOTHA. *The Anophelini of the Ethiopian geographical region.* (Publ. No. XLIX, Vol. X.) Johannesburg: South African Institute for Medical Research, 1947. Pp. 272. (Illustrated.) 30/– net + postage.

EIGSTI, O. J. (with a supplement by P. Dustin, Jr.). *Colchicine bibliography.* (Published in *Lloydia*, Vol. 10, No. 2.) Cincinnati: Lloyd Library, 1947. $.50.

GITLOW, ABRAHAM L. *Economics of the Mount Hagen tribes, New Guinea.* (Monographs of the American Ethnological Society XII.) New York: J. J. Augustin, 1947. Pp. xi + 110. (Illustrated.) $2.75.

GORTNER, WILLIS A., ERDMAN, FREDERICK S., and MASTERMAN, NANCY K. *Principles of food freezing.* New York: John Wiley; London: Chapman & Hall, 1948. Pp. xiii + 281. (Illustrated.) $3.75.

HUSTON, RALPH CHASE. *A correlation of some physical properties of alkanes and alkenes: boiling points, molecular volumes and surface tensions.* East Lansing: Michigan State Coll. Press, 1947. Pp. vii + 96. $1.75.

KENDALL, JAMES I. *Microscopic anatomy of vertebrates.* (3rd ed.) Philadelphia: Lea & Febiger, 1947. Pp. 354. (Illustrated.) $6.00.

LANTIS, MARGARET. *Alaskan Eskimo ceremonialism.* (Monographs of the American Ethnological Society XI.) New York: J. J. Augustin, 1947. Pp. xiii + 127. $2.75.

LEWIN, PHILIP. *The back and its disorders.* New York-Toronto: Whittlesey House, McGraw-Hill, 1948. Pp. xiii + 157. (Illustrated.) $2.50.

LORAND, SANDOR. (Ed.) *The yearbook of psychoanalysis.* (Vol. 3, 1947.) New York: International Universities Press, 1948. Pp. 309. $7.50.

MOSCHCOWITZ, ELI. *Biology of disease.* New York: Grune & Stratton, 1948. Pp. vii + 221. (Illustrated.) $4.50.

MUNCIE, WENDELL. *Psychobiology and psychiatry: a textbook of normal and abnormal human behavior.* (2nd ed.) St. Louis, Mo.: C. V. Mosby, 1948. Pp. 620. (Illustrated.) $9.00.

NEWMAN, JAMES R., and MILLER, BYRON S. *The control of atomic energy: a study of its social, economic, and political implications.* New York-Toronto: Whittlesey House, McGraw-Hill, 1948. Pp. xiii + 434. $5.00.

PARKER, GEORGE HOWARD. *Animal colour changes and their neurohumours: a survey of investigations, 1910–1943.* Cambridge, Engl.: at the Univ. Press, 1948. Pp. x + 377. (Illustrated.) $6.50.

RICKETT, HAROLD WILLIAM. *The Royal Botanical Expedition to New Spain, 1788–1820.* Waltham, Mass.: Chronica Botanica; New York: Stechert-Hafner, 1947. Pp. v + 86. (Illustrated.) $2.50.

RITCHIE, JOHN W. *Biology and human affairs.* Yonkers-on-Hudson, N. Y.: World Book Company, 1948. Pp. xiv + 818. (Illustrated.) $3.40.

ROSTAND, JEAN. *Charles Darwin.* Paris: Gallimard, 1947. Pp. 239. (Illustrated.) 220 fr.

THE ROYAL SOCIETY. *Newton tercentenary celebrations, 15–19 July 1946.* Cambridge, Engl.: at the Univ. Press; New York: Macmillan, 1947. Pp. 15 + 92. (Illustrated.) $3.00.

RUSSELL, PAUL F., *et al.* (Eds.) *The use of aircraft in the control of mosquitoes.* New Brunswick, N. J.: American Mosquito Control Association, 1948. (Booklet, illustrated.) $1.25, Association members; $1.50, nonmembers.

SCARBOROUGH, J. B., and WAGNER, R. W. *Fundamentals of statistics.* Boston: Ginn, 1948. Pp. vii + 145. (Illustrated.) $2.40.

SMULLIN, LOUIS D., and MONTGOMERY, CAROL G. (Eds.) *Microwave duplexers.* (MIT Radiation Laboratory Series.) New York-Toronto-London: McGraw-Hill, 1948. Pp. xiv + 437. (Illustrated.) $6.00.

SPANGENBERG, KARL R. *Vacuum tubes.* New York-Toronto-London: McGraw-Hill, 1948. Pp. xvii + 860. (Illustrated.) $7.50.

STEPANOFF, A. J. *Centrifugal and axial flow pumps: theory, design, and application.* New York: Wiley; London: Chapman & Hall, 1948. Pp. x + 428. (Illustrated.) $7.50.

SZENT-GYÖRGYI, A. *Nature of life: a study on muscle.* New York: Academic Press, 1948. Pp. 91. (Illustrated.) $3.00.

TERZAGHI, KARL, and PECK, RALPH B. *Soil mechanics in engineering practice.* New York: John Wiley; London: Chapman & Hall, 1948. Pp. xviii + 566. (Illustrated.) $5.50.

ZOETHOUT, WILLIAM D. *Introduction to human physiology.* St. Louis, Mo.: C. V. Mosby, 1948. Pp. 424. (Illustrated.) $4.00.

ZOETHOUT, W. D. *Laboratory experiments in physiology.* (4th ed.) St. Louis, Mo.: C. V. Mosby, 1948. Pp. 263. (Illustrated.) $3.00.

———. *Manual of laboratory safety.* Pittsburgh-St. Louis: Fisher Scientific Company; New York: Eimer and Amend, 1948. Pp. 34. (Illustrated.) Gratis.

———. *Method of performing and interpretation of results of serum phosphatase test.* (Rev.) Milwaukee: Paul Lewis Laboratories, 1948.

———. *Studies and essays presented to R. Courant on his 60th birthday, January 8, 1948.* New York: Interscience, 1948. Pp. 470. $5.50.